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A

SYSTEM OF SURGERY.

VOL. I.

GENERAL PATHOLOGY.

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A

SYSTEM OF SURGERY,

THEORETICAL AND PRACTICAL,

IN

TREATISES BY VARIOUS AUTHORS.

EDITED BY

T. HOLMES, M.A. CANTAB.
ASSISTANT SURGEON TO THE HOSPITAL FOR SICK CHILDREN.

IN FOUR VOLUMES.

VOLUME THE FIRST.

GENERAL PATHOLOGY.

LEEDS SCHOOL

LONDON:
JOHN W. PARKER AND SON, WEST STRAND.
1860.

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PREFACE.

THE object of this book is to unite into a complete system the opinions and experience of many men, most of them Hospital Surgeons in London, and most of them writing on subjects of their own choice. As each subject must be treated with something of the completeness of a monograph, the work must necessarily be voluminous; but both Contributors and Editor have done their best to present each essay in as moderate a compass as the topic would allow. Where so many men unite in writing on parts of one great subject, it is hardly possible to avoid some differences of opinion; but none of much importance will, it is hoped, be detected in the following pages, and certainly none which can destroy the uniformity of the teaching.

The arrangement adopted in this work is as follows:

I. The diseases which affect the whole system are first described, and this part comprises the essays ending Vol. I. p. 569.

II. The next part treats of injuries which either involve the whole or a large part of the body, or which may be met with in any region. This extends to the end of the essay on Gunshot Wounds, at the commencement of the Second Volume. These two parts comprise the whole subject of Surgical Pathology.

III. The various local injuries are next described;

and in this part the anatomical order has been followed, the body having been divided into eight regions,—the Head, Face, Neck, Thorax, Back, Pelvis, Upper and Lower Extremity. By this plan it was thought that the injuries which affect the same parts, and which in practice have to be diagnosed from each other, would be brought into the same part of the book and under the treatment of the same author.

IV. The principles of operative and minor Surgery, and of the employment of anæsthetics, follow the essays on local injuries.

V. The next part comprises the surgical diseases of the various organs of the body. These have been arranged according to the function of the parts affected: as diseases of the organs of special sense—the Eye, Ear, and Nose; of the organs of locomotion—the Bones, Joints, Muscles, Tendons, and their Sheaths, &c.

VI. An Appendix completes the work, comprising the Principles of Surgical Diagnosis, of the Surgical Pathology and Treatment of Children's Diseases, the Construction and Management of Hospitals, and various miscellaneous matters which it was found difficult to bring under any of the previous heads.

This arrangement has been chosen, not as being free from objections, but as the best which suggested itself. The principal objection, perhaps, is the difficulty of separating the direct effects of injury from those diseases which frequently result from injury; but it is hoped that it will be found to have the merit of being intelligible, and of not making unnecessary artificial separations between things nearly connected in practice.

Any difficulty which may be found in discovering the place of any subject will be met by the analytical Tables of Contents at the head of each volume, and the copious Index at the end of the work.

For the plan of the work the Editor must be held responsible; the opinions expressed in each separate essay rest upon the authority of the writer, whose name is signed to it.

The Editor must express his deep sense of the honour done him in selecting him for the important task of preparing this book and seeing it through the press. He has endeavoured to discharge his difficult duties to the best of his ability;—had it not been for the unfailing courtesy and willing coöperation which he has experienced from all the Contributors, it would have been impossible to perform them at all;—nor could the scheme have ever been realised but for the energy and liberality of the Messrs. PARKER. The Editor, as well as all connected with it, have to lament, in the premature death of Mr. PARKER, Junior, one who was warmly interested in the success of this undertaking, whose friendship the Editor was happy enough to form in consequence of their common connection with it, and from whom he constantly received valuable advice and encouragement.

T. HOLMES.

22 QUEEN STREET, MAYFAIR,
December 1860.

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AND THE GENERAL EFFECTS OF SHOCK UPON THE SYSTEM.

By W. S. Savory, Esq.

PROFESSOR OF COMPARATIVE ANATOMY AT THE ROYAL COLLEGE OF SURGEONS.

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By T. Holmes, Esq.

ASSISTANT SURGEON TO THE HOSPITAL FOR SICK CHILDREN.

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INFLAMMATION.

IT is here proposed to consider generally the pathology and the treatment of Inflammation.

In those subsequent sections of the work which refer to diseases and injuries of particular organs, there will be better opportunity for discussing, how far this or that organ when it is inflamed gives distinctive characters to the inflammation affecting it, or requires that such inflammation should be treated by peculiar means. In the present essay, therefore, such local specialities of the subject will be but lightly touched upon; only so far, indeed, as may be necessary to illustrate general statements or to render them correct and complete. Thus, for instance, the student who wishes to learn all that may practically aid him with reference to the diagnosis or treatment of ophthalmia or of synovitis will refer to those after-pages in which DISEASES OF THE EYE and DISEASES OF THE JOINTS are considered. Likewise what relates to specific varieties of inflammation may be more advantageously studied in the sections which are devoted to SYPHILIS, SCROFULA, CARBUNCLE, ERYSIPELAS, and other like subjects. Even the so-called terminations of inflammation will not be exhaustively considered in this general article; for many of the facts connected with them can, at least for practical purposes, be more conveniently classed under such special heads as those of ABSCESS, ULCER, and GANGRENE.

Notwithstanding these limitations, the present subject is of large scope and of equally large importance. To any one who makes with it his first acquaintance, the study seems to branch almost throughout the whole subject-matter of surgery. Nor does a more critical inquiry tend very greatly to abate this first impression. For among the infinite varieties of surgical casualty and disease, singularly few are the cases which do not at some moment of their course—either in their origin, or in their complications, or in their treatment, involve an appeal to those laws of textural irritability which determine the phenomena of inflammation. And assuredly it is no exaggeration to say, that rational surgery depends more upon a knowledge of the inflammatory process than upon all other pathological knowledge put together.

I. Etymology.

The word "inflammation" is a very old one. That burnt or wounded external parts are apt to become hot, red, painful and swollen, must have been among the first observations of mankind. The increased heat of the injured part, or the sufferer's feeling of increased heat in it, seems especially to have fixed popular attention; and from time immemorial it has been the case, that words which denote the physical fact of *having been set on fire*—such words as ours of "inflammation" (deriv. *flamma*, φλεγμα, φλεγειν) have been used with regard to textures of the living body, to express their undergoing that peculiar morbid change which external injury excites in them.*

But the terms in question have not, in their application, been restricted to the results of local injury. So far back as medical literature extends, they have embraced cases, both of external and of internal affection, where like phenomena arise independently of exterior lesion.

This seems a simple matter. Conclusions which were formed as to external diseases would soon extend themselves to whatever seemed kindred in the symptomatology of internal organs; and the earliest observers of gout, carbuncle, or erysipelas must have seen that pain, redness, heat and swelling may arise in exterior parts of the body without any known provocation by chemical or mechanical injury.

Yet it deserves notice that so many centuries ago, medicine had achieved the important generalisation which is implied in our present use of the word "inflammation." Observers had already mastered one very great lesson in pathology. They had learnt to recognise the morbid action irrespectively of its site or cause. They had learnt to speak of inflammation as a definite state of disease which various causes might produce, and into which any organ might be brought; but which, however caused, or wherever existing, was to be considered as substantially the same.

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* Every one who reads the German language will recognise that the above statement applies to it (in respect of its word *Entzündung*) and generally to the languages having affinity with German, as much as to the Greek and its derivatives. But the following memorandum, for which the writer is indebted to the kindness and learning of Mr. Charles Rieu of the British Museum, shows the same thought to have been at work in much older languages: "I find that the Arabic equivalents of 'inflammation' in its medical sense are التهاب *iltiháb* (literally a blazing-up), and also حرارة *harárah* and سخنة *sakhanah*, which both mean *heat*. In Sanscrit I find दाह *dáha* (burning), ज्वाला *jválá* (flame), ताप *tápa* (heat), with its compounds *upatápa* and *santápa* (internal or general heat). My learned friend Mr. Zedner tells me that the best Hebrew equivalent is קדחת *kadakhat* (kindling, burning), which is especially applied to the burning of the fever."

II. Description of the Inflammatory Process and of its Symptoms and Causes.

A. THE PROCESS.

Perhaps the readiest way of commencing the study of inflammation is to start from some particular instance which may be regarded as characteristic and typical.

Taking then, for illustration's sake, an ordinary case of carbuncle,—what, let us inquire, are the main facts which present themselves to the observer? A more or less considerable circle of texture at the surface of the body is, with great pain to the patient, converted into a red, hard, hot swelling. Presently the skin begins to soften at certain points, and holes form in it there. Fluid discharge drips from them. They widen and become confluent into freer openings, eventually one or more, over the middle parts of the tumour. A quantity of dead, putrescent tissue—not at first loose from the surrounding parts, but connected and continuous with them, is thus exposed. Gradually this *slough* becomes free. In a state of common putridity, it either escapes or may be drawn through the perforated skin; leaving, where it lay, a proportionate cavity from which discharge still runs. This discharge, which hitherto has been tainted with decaying animal matter, now gradually ceases to be foul, and presently settles into the condition of what is called *laudable pus*—an inoffensive, opaque, yellowish-white, creamy fluid, which the microscope shows to be so teeming with characteristic corpuscles (hereafter to be more particularly described), that it may almost be said to consist of them. Meanwhile the cavity gets lessened by the encroachment of a soft, red material into which its walls develop themselves; rising at first, as it were, in many separate buds of growth, and then advancing in one mammillated, wavy sheet of so-called *granulations*. With progress from day to day, this granulating surface attains the original level of the part. Cuticle, like that of the adjoining skin, then forms on it; and the subjacent parts are thus once more, as is their nature, wrapped over by the normal continuity of sensitive and vascular integument.

Next, as though some of this filling-up material had been a mere temporary scaffold for cuticle to form upon, the repaired part begins to shrink and pucker; so that eventually (as the sign that substance has been lost) there remains a depression or intraction of surface—an area, within which the healed integument, traversed by pale hard seams of scar, is bound down more or less tightly to the tissues over which it should glide.

Before this process can be understood, some points in the morbid anatomy require to be more minutely investigated: partly as shown on the surface, partly as shown in a cut (such as the surgeon commonly makes in the disease) across the centre of the carbuncle from one side of it to the other.

Centrally there is the slough; and of this little more needs now be said than that it is a mass of dead subcutaneous tissue, sodden with dead juices, and (though it be still coherent with the living body) undergoing ordinary post-mortem putrefaction. The microscope shows in it the breaking-down forms of areolar tissue, large drops of oil which have escaped from fat-cells, grains of darkened pigment concreted from the diffused soakage of blood, and a very dense clouding by incoherent granular matter (more or less dotted with minute oil-drops, but otherwise chiefly proteinous) which represents the débris of dead tissue and of unorganised interstitial juices. The discharge which runs from the ulcerated openings derives its quality of foulness from the taint of this decaying animal matter (shreds and particles of which are brought away in it) and retains that quality till the act of separation is complete.

Beyond the circumference of the slough, slighter traces of textural disintegration may still here and there be found. But the chief thing to be observed in these surrounding textures is, that they are profusely infiltrated with material foreign to their natural construction—material which, when examined by the microscope, is found teeming with rudimentary forms of new growth. For some considerable distance around the slough this act of organic production is exhibited; and it is but the same act continued, which, when the slough has been shed, gradually encroaches on the resulting gap, and at last accomplishes its repair. These forms are to a great extent identical with those which fall in fluid discharge from the ulcerated opening of the carbuncle, and characterise that discharge as pus. They differ only thus far,—that, whereas the discharged pus-cells are generally at about one stage of development and are entirely free and floating, the infiltrated cells vary somewhat in their degrees of ripeness; a larger proportion of immature forms being among them, and many seeming to take part in the construction of solid tissue. These points will hereafter be more particularly adverted to.

Throughout the space where new development is proceeding, blood-vessels full of blood seem to be extraordinarily abundant, and the same condition of hyperæmia extends beyond the limits of that reproductive area, making a wide zone of redness which at its circumference gradually fades off into the colour of the surrounding skin.

Such—omitting some details which are unimportant for the present purpose, such are the main physical facts which may be observed in any part of the body which is the seat of carbuncle. If they be stated in their most general form, with reference to the nature of their result, the entire process may be said essentially to consist in a *local change of material.* LOSS OF SUBSTANCE and REPRODUCTION OF SUBSTANCE are the simple totals into which, physiologically speaking, the details admit of being generalised; and especially it deserves notice that these two opposite actions are manifested thus simultaneously in the part,—so that at no stage of the disease is there any show of destruction without something of renewal at its side.

It would seem, then, that, in general meaning, though obviously not in form or degree, the actions which have been described have some affinity to the ordinary process of textural nutrition. For a change of organic material—a textural substitution of what can be vitalised and made efficient for what is worthless and effete, this is the very gist of the so-called "nutritive process." It is this which is the one work of organic or vegetative life.—*La vie est un tourbillon continuel.*—What, then, are the differences between the ordinary manifestations of this life, and those morbid manifestations which have been described?

First, let it be remembered, that carbuncle has here been brought forward as a type of the inflammatory process; and what has been said of it is substantially meant of every inflammatory action. A great slough dischargeable through an opening in the integument, a great suppurating gap to be filled up by protracted efforts of granulation,—these, it is true, are not elements in every act of inflammation. For inflammation has its degrees; and those extreme results need not be attained in order to constitute what is essential to it. But though the degree be less, the kind must be the same. It is essential to inflammation that, if not to that extent, at least to an appreciable extent, there shall be proceeding in the inflamed part, side by side with one another,—first, a destructive process which physiologically may be compared with the gangrenising action in carbuncle, and secondly a productive process which physiologically may be compared with the suppurating and granulating actions in carbuncle.

This assertion will immediately be justified by reference to the concurrent phenomena of destruction and growth in various cases of inflammation. Meanwhile, as regards the difference between these actions when they occur in health and when they occur in inflammation, it may here suffice to observe, empirically, that the *appreciability of the opposed results* is in itself a differential mark of inflammation. In healthy tissues, during their normal self-mutation, the anatomist does not at any given moment find either palpable detritus to express their waste of material, or multiplying embryonic forms to express their action of repair. The changes of matter—the degeneration and removal of what is effete and the substitution of what is useful, occur there so evenly and proportionately that separate steps are not marked in the process, nor can any contrast be found between the respective elements of declining and nascent tissue. But in inflamed parts, as has been said, these manifestations are made. A more or less considerable rubbish of old texture, and a more or less considerable germination of new forms—these, side by side, and in contrast, are pathognomonic in the anatomy of inflammation. More detailed inquiry must now be made into the grounds of this generalisation.

1. *Inflammation as a destructive process.*

The forms of inflammatory destruction are less different than the superficial observer might believe. And not only is it the case, as will hereafter appear, that pathologically they cannot be separated; but practically also it is found, that those of them which to the common eye seem most disorganising and mutilative cannot complete themselves unless the so-called other forms co-exist and co-operate with them.

First, there is *gangrene;*—the death of a bit of body, and its abandonment to the same sort of changes as it might undergo in the dissecting-room. These changes are unmixedly chemical. Of necessity they express themselves less in the comparatively unperishing material of bone, than in the rapidly putrefying soft textures of the body. In the latter textures they proceed like common cadaveric putridity; proportioning themselves to local conditions of succulence and temperature, and giving of course different products according to the chemistry of the material which rots. Whoever knows what changes occur in an element of the body separated from the rest, and kept macerating at temperatures of F. 60°-100°, can predict what changes the same element would undergo if gangrenised in connexion with the body.

As regards the different amounts in which inflammation may produce gangrene, the student must remember that, in the sense of our present discussion, great gangrenes—such as are witnessed in the necrosis of masses of bone or in the sphacelation of entire limbs, are but extreme instances at one end of a very extensive scale; that, pathologically, there are many illustrations of gangrene to which, surgically, the word is not applied; that in the formation of any common blister, for instance, the raised cuticle consists of material irrecoverably dead; and that every epithelial desquamation is in fact the shedding of an epithelial slough.

Secondly, there is *ulceration;*—the process, by which holes are made through the surface-textures of the body (cutaneous, mucous, articular, or serous) and hence perhaps into deeper parts;—a process, which differs from gangrene mainly in the fact that it proceeds more gradually and molecularly. At the place where an ulcer exists, the absent texture perished as truly as by gangrene: but while gangrene would have occasioned its abrupt separation in mass, ulceration permitted its progressive shedding as detritus. The discharge from any spreading ulcer, if examined under the microscope, invariably exhibits particles of disintegrating tissue; and the so-called "foulness" of an ulcer is but gangrene on a smaller scale.

Thirdly, there is *liquefaction;*—the process, by which the covered-in textures of the body are enabled to waste away their material, just as by ulceration the surface-textures can waste away theirs; a process, which without making any surface-gap in the body, can fuse away so much material that the affected organ is left excavated, attenuated or scarred; a process, which, like ulceration, begins as a process of softening, and differs from ulceration only in its more complete disorganisingness; for the perishing tissue (having no vent but through the blood) cannot be shed in sensible particles, and therefore must be so absolutely disintegrated and fluidised as to be capable of soaking through the membrane of capillary blood-vessels.

And thus the destructive acts of inflammation form, in their several kinds and degrees, one long series, which, with no sudden breaks or contrasts in it, extends from the confines of normal texture-waste to the utmost excesses of gangrene. For assuredly the common changes of material which attend every vital action—the changes which permit certain elements of every used texture to pass away effete from the rest, are changes which include liquefaction;—and inflammatory softening may be traced up in successively finer manifestations till at last it confounds itself with these changes. Healthy waste of texture leaves, we repeat, no perceptible detritus. As the working texture molecularly perishes, so molecularly it melts away. Getting thus continuously freed from all worn-out material, it has no local rubbish-heap to show—no lot of superseded decomposing particles. But as we descend from the confines of health, we lose this clean perfection of result. Step by step within the regions of marked disease, we find an increasing crudity of waste-product. Tissue is destroyed in inflammation quicker than it can be dissolved and removed. Refuse materials, with more or less trace of texture remaining in them, can be perceived with the microscope, perhaps even with the naked eye. These are the particles which characterise the discharge of spreading ulceration; and which, with the softening of any covered-in organ, constitute, till gradually their liquefaction is completed, the pathological link between softening and ulceration. In what the surgeon commonly recognises as gangrene, the essential fact stands out of course most conspicuous:—inflammation has suddenly killed a mass of organic substance (say a foot or a tonsil) not punctatively, so that dead particles are interspersed amid living particles, but with an uniform death in its entire solidity. And now, what becomes of this killed bit of body? something of it liquefies, and, where nearest to living capillaries, passes, as in common softening, into the circulation; something of it breaks off in shreds, and, where nearest to the surface of the body, is discharged as though it were the shedding of ulceration: but the bulk is too solid to be thus disintegrated in its entirety; and when, by ulceration and liquefaction, its circumferential parts are loosened from living contiguous tissues, it drops off, as something with which the body has no further concern, to complete its decomposition at a distance.

It is not in regard of these last-mentioned extreme degrees, that the student runs risk of overlooking the reality of destructive changes as an essential part of inflammation. But both for pathology and for practice, it is needful that he recognise the same reality in cases where it is less obvious—that he learn to trace the anatomy of inflammatory destruction from its grossest to its most minute phenomena.

Let him examine inflamed muscle,* as, for instance, in the post-mortem examination of a compound fracture or of a recently made stump:—He will find the structure weakened, so that it easily gives way with pressure or traction; he will see, under the microscope, that the substance tends to fall into irregular fragments; that its natural striation is more or less replaced, first by an almost homogeneous appearance, and afterwards by an appearance of aggregated granules; that, with these granules of albuminous matter into which the muscle has resolved itself, there is mixed, even from an early date in the inflammation, a noticeable quantity of minute oil-drops; that often these oil-drops appear before the disintegration of muscle has made much progress, and then arrange themselves in such mutual relation, transverse or longitudinal, as to suggest that the sarcous elements have changed themselves, particle by particle, into oil; that little by little the oil-drops multiply to such an extent as to be the chief visible objects,—the limitary membrane of a fasciculus seeming now to be almost filled with finely-divided oil, diffused through some scanty connective albuminous material; that the limitary membrane, within which the muscular material is thus emulsionised, tends also itself to undergo dissolution, and let its proceeds confuse themselves with the similar débris of neighbouring fasciculi, till more or less bulk of muscle is reduced to a state of oleo-albuminous liquidity. And from this point, if the observer have opportunity of watching the changes which lead to convalescence, he will see that gradually the liquefied material diminishes in volume; that, in proportion as it vanishes, the adjoining parts adapt themselves to the altered relation; that eventually only a scar-like puckering of substance—a kind of tendinous intersection, remains to mark the place where muscular material has irrecoverably melted away.*

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* These changes may advantageously be compared with those which

Let him examine inflamed bone—as, for instance, in a carious vertebra:—He will see that the structure breaks down under his finger, and offers scarcely any resistance to a knife; that the microscopical texture is rarefied—cancelli, canals, lacunæ, being all larger than natural, and the solid framework all scantier; that the material is tending to break into its component parts, and to undergo changes which admit of its being removed by the circulation. In many cases (for example, under the irritant pressure of an

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fibrinous clot undergoes, when it softens, either within or without the body. Compare Gulliver, in *Med.-Chir. Transact.* vol. xxii.

* This description (verified of course by many personal observations) is founded on that so suggestively given by Virchow in his paper on parenchymatous inflammation; *Archiv*, vol. iv.

aneurism) he will find that a quantity of bone has thus gone, leaving no trace behind,—gone, of course, only after having first become liquid; and it appears[*] that, when bone is inflamed, the first step towards this disintegration consists in a breach of the ordinary union between the mineral and cartilaginous constituents, with a primary removal of the former, and a chemical change of the latter. If there be discharge from the inflamed part, there will be found in it bits of bone, chemically and microscopically demonstrable.

Let him examine inflamed nerve,—as, for instance, near to where it has been cut in amputation:—He will find, says Dr. Lent,[†] the medullary cylinder of each nerve-tubule falling, as it were by cross cuts, into irregular pieces—at first large, but, as the process advances, getting smaller and rounder, and assuming the character of oil; till at last the tube-membrane is filled with oily material, which gradually undergoes removal.

Let him examine the hard textures of an acutely suppurating joint:—He will find the strongest ligaments in course of being reduced to an incoherent state—either actually pulpy and half-liquefied and in course of removal, or ready to break with the least traction; he will find (unless proper splintage have been used to prevent it) that dislocation is occurring from this cause; he will find, if the inflammation have been primarily synovial, that the cartilage is smoothly melting away at its surface into the fluid which bathes it, or, if the disease have begun subarticularly, that the cartilage, where superjacent to carious bone, is irregularly eroded and perforated; and throughout, with the microscope, he will find, wherever there are evidences of advancing disintegration, that the softening material is abundantly marked with oil-drops.

Let him—not in post-mortem examinations, for which there are no opportunities, but during life, observe the results of inflammation of the sclerotic, and ask himself why it is that staphyloma so often follows this disease:—He will infer that here, as with other cases which we have considered, the inflammation must have so disorganised the texture and so enfeebled its normal rigidity, that it can no longer give sufficient resistance to pressure from within, or save itself from being bulged by what now becomes an almost dropsical excess of fluid secretion within the globe.

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[*] See Von Bibra, *über die Zersetzung welche die Knochen durch Caries erleiden;* Liebig u. Wöhler's *Ann.* vol. lvii. Compare Gendrin, *Hist. Anat. des Inflammations,* vol. i. § 460; Howship in *Medico-Chir. Transact.* vols. viii. x.; Virchow, loc. cit.; and Von Bibra's *Chem. Untersuch. verschiedener Eiterarten*, 1842.

[†] *Zeitschrift für wissenschaftliche Zoologie*, vol. vii. p. 145. Compare Schiff, in same work, p. 338, and in previous publications—*Archiv d. Vereins f. gemeinsch. Arbeiten*, 1853, and *Comptes Rendus*, t. xxxviii.

Above all, let him examine the products of inflammation furnished by mucous and serous membranes, and by glands;—the expectorations of bronchitis, the hawkings of common throat-catarrh, the urine of scarlatina, the acute effusions of serous cavities, and, after death, the inflamed organs themselves. Let him once thoroughly recognise the destructive acts of inflammation, as illustrated in the simple cells of gland or epitheliated membrane; and the whole of this argument will be compendiously before him. He will find cells (especially where they are squamous) shed as dead material, without their having first undergone any appreciable alteration. He will find all others undergoing change in a more or less marked degree,—change, of which the essence consists in a loosening and eventually a disintegration of texture, with increased imbibability by fluid, and gradual accumulation of oil; so that the cell, while undissolved, appears of larger than natural size, its wall less defined, its nucleus dimmer, its contents more granular and more oily than in health. Sometimes a cell is thus converted into a mere heap of oil-drops held together by little intervening or surrounding material; sometimes there will be more albuminous matter, perhaps in a granulated or dotty form; sometimes there will be more evident fluidity of contents; but in any case the cell, if retained within the body, tends to break up and contribute with its neighbours to the making of an oleo-albuminous fluid, in which there exist but scanty and evanescent remains of the original cell-structure.

It is to be observed that in all these changes the process of inflammatory softening involves something more than the mere deliquescence of tissue. The material which ceases to be consistent does not retain, as if only in a more watery state, its original chemical constitution. In beginning to soften, it also begins to show new ingredients,—the result, as will presently appear, of new combination of its elements. And the common mark of this chemical change is that oil-drops, sometimes with other forms of free fat, become, to a greater or less extent, visible in the microscopy of the softening part; so that often, during some stages of the process, fat appears to be the principal residue of texture.

How very important are the bearings of this fact, can only be learnt by considering under what other circumstances (apart from inflammation) the albuminous and gelatinous materials of the body undergo fatty transformation. For such study enables us to say that universally, where this change occurs, its occurrence has the meaning of *degeneration.* And the fact that it habitually forms part of inflammatory changes of texture would therefore in itself, if there were no other proof, be sufficient to show that inflammation includes a devitalising process.

This argument is so important, that a momentary digression may be excused, in order that the general meaning of non-inflammatory fatty transformation may be clear. Universally, we have said, it denotes degeneration:—not simply because fat is of less chemical complexity—is nearer to the inorganic world, than albumen or gelatin; not simply because fat, infiltrated through a part, is, so far as we know, incapable of contributing to the mechanical or dynamical usefulness of the part; but further because the circumstances under which the change occurs, when apart from inflammation, are without exception circumstances which have in them the nature of death. That it occurs to an immense extent in the tissues of the aged, is but an illustration of this truth:—it is, so to speak, with a foretaste of death, that, as we near the natural end of our lifetime, the heart and arteries, and to a less extent the voluntary muscles and the hard textures, undergo this irreparable change. That it occurs also in the textures of the placenta towards the close of utero-gestation* is an exactly equivalent fact,—that it occurs namely in them, as they verge on the natural term of their existence—occurs in them as relatively senile, in contrast to the textures of mother and fœtus which show no traces of such a change. And these facts get their complete intelligibility, when it is further known that fatty transformation occurs abundantly after death:—witness the now well-known conversion of dead flesh into adipocere; the enormous fattiness of certain geological strata† in which animal remains are abundant; and, not least, Dr. Quain's experimental demonstration that muscular substance, perfectly healthy at the time of death, will within a few weeks, if kept moist without access of air, assume all the characters of fatty degeneration.‡

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[*] See Dr. Druitt's paper on Degeneration of the Placenta at the end of pregnancy; *Med.-Chir. Transact.* vol. xxxvi.

[†] Dr. Michaelis (op. inf. cit.) says the Jura lias is so full of fat from the transformation of the millions of cephalopods, saurians and fishes contained in it, that in Wirtemberg there have been projects for using it to make gas.

[‡] "It is of a pale cream-colour; it is soft; portions of it float in water, and when examined with the microscope, exhibit the most advanced state of degeneration, differing from that which occurs during life in this respect alone,—that it is universal." *Med.-Chir. Transact.* vol. xxxiii. p. 142.

To the same effect are the very interesting observations which of late years have been made on the changes which take place in animal matters, dead or with reduced vitality, if they be artificially kept in contact with normal textures of the living body. In the course of verifying some experiments which Berthold (in imitation and extension of John Hunter's inquiry) had made on the transplantation of testicles, Prof. Wagner* found that a testicle, removed from one animal and engrafted in the peritoneal cavity of another, underwent fatty transformation in its new site. Continuing the line of research which this curious fact suggested to him, he soon learnt that not only testicle, but other organs or parts of organs, similarly transplanted, would undergo the same change—crystalline lens, for instance, and muscular substance; and presently going a step farther, he found that bits of boiled white of egg, passed into the peritoneal cavity, underwent a precisely similar transformation. This discovery has been fully confirmed by other observers;† but different opinions were held as to the signification of the facts;—Prof. Wagner himself believing that there was true transformation of albumen into oil and residual matter; while others believed that the albumen, as such, passed by mere dissolution into the blood, and that the oil was a new, substituted and, as it were, secreted material. Dr. Burdach, of Königsberg, attempting to establish the latter view by experiment, found (1) that albumen, dried, and cased in capsules of collodion, would not become greasy within the peritoneal sac; and (2) that bits of elder-pith, let lie within the peritoneum so as to be permeated by animal juices, would, after a while, show oil throughout their porous texture:—but these interesting results fell short of establishing his point; not proving more than (1) that access of fluid is necessary for the albumen to become greasy, and (2) that inflammatory effusion, stagnant within the body in a dead porous substance, into which it has soaked, will itself become greasy.* The question seems, however, to be fully answered—and that in a sense opposite to Dr. Burdach's conclusions, by certain chemical facts elicited by Dr. Michaelis:†—for he, imitating Prof. Wagner's experiments with bits of muscle and of fibrin, succeeded in showing that, at the same time as these substances were becoming visibly greasy, ammonia was being developed;—a demonstration which, by accounting for the nitrogen of the former albuminous compound, supplied a link hitherto wanting to the argument, and enables us with almost absolute certainty to say that, under the circumstances described, albuminous matters actually undergo decomposition and leave fat with ammonia in their place.

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* *Verhandl. der Götting. Academie*, 1851.

† Comp. especially Middeldorpf, whose experiments showed the same changes to be producible in bone and cartilage;—abstract given by Dr. Burdach, in Virchow's *Arch.* vol. vi., with a reference to Dr. F. Gunsburg's *Zeitschrift für klinische Medicin.* Similar experiments are sometimes performed by nature. Such an one is represented, as Prof. Virchow (*Würzb. phys. med. Verhandl.* B. iii.) has pointed out, in the facts of extra-uterine gestation; and here he has found the dead fœtal textures, where nearest to the mother's juices, presenting accumulations of oil. A neat illustration of the same sort is given by Dr. James Salter (*Patholog. Transact.* vol. vi. p. 169) as furnished by the tooth-pulp, when it is accidentally cut off from its organic connexions, and remains boxed-up, but dead, within the pulp-cavity:—for, under these circumstances, he says, the tooth-pulp assumes a fatty condition, and the dentine of the necrosed tooth becomes permeated with fat. How analogous to these circumstances are those of brain-texture, when its arteries are obliterated, will occur to every one who studies a case of atrophic brain-softening.

Generally then it may be said of uninflamed textures, that an extensive presence of oil in them is essentially a sign of weakness or death; that it represents decomposition of the effective material; that it results‡ from actions "independent of those processes which we call vital;" that it is virtually of the nature of putrefaction.

And reverting now to inflammation, we may repeat that, whenever it is in progress, the textures which it affects present more or less of this change—now identified as degenerative. That gangrenous masses undergo putrefaction because they are derelict of life, is not likely to be questioned: but, that also the processes of ulceration and softening are essentially cadaveric changes of texture, has required more ample exposition.

There remain indeed certain fine manifestations of inflammatory destruction, which we can only interpret by analogy: for there are cases, where irritated texture goes, without giving us any opportunity of examining its débris. But here we can only infer that such vanishing of texture (perhaps chiefly of intercellular or internuclear material) represents an excess of those actions which normally waste all operating textures,—actions which, however molecular or impalpable, are of course, from the nature of the case, essentially akin to death. Of these, in their relation to nascent inflammation, something more must hereafter be said. And hereafter also must be considered the share which life takes in stimulating the process of ulceration; the share which it takes, for instance, in making bone disintegrate at the circumference of a sequestrum with infinitely more rapidity than mere dead bone disintegrates.

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* The phenomena of arcus senilis get their best interpretation from those experiments of Dr. Burdach's with elder-pith in the peritoneum. Starvation-ulcers of the cornea occur at its centre, where the access of nutriment is least: fatty degeneration at the circumference, where the access of nutriment is most ample. No doubt this means, that much or all of the fat results from degeneration rather of blastema than of texture; that the cornea is but half-vitalised, that the juices penetrating it are circumstanced almost as those peritoneal juices in the elder-pith, and show most change where they are most supererogatory to the tissue.

† *Prager Vierteljahr-Schrift*, 1853.

‡ Quain, loc. cit.

In closing this section it may be mentioned that, just outside the range of actions which are called inflammatory, there are some of interest to our present subject. When certain cartilages, under the slight but continued stimulation which spreads to them from a neighbouring inflamed texture, become ossified or show fibrescence of their intercellular material (as, for instance, the cartilages of the larynx during phthisical inflammation of the mucous membrane which covers them) the change is, in its essence, identical with those we have been considering. If not a change of death, it is a change towards death. It is a change essentially senile, an anticipation of that which time would normally have brought to the texture. The given textural irritation determines the coming-on of a textural old age; just as a greater irritation would at once have hurried the texture to death.

2. *Inflammation as a productive process.*

In connexion with that generative effort which is described as the second essential element in every inflammatory process, there are some collateral phenomena for study. If we suppose an inflamed texture to be the seat of an increased growth, we presuppose the texture to be more than commonly infiltrated by that fluid blastema which alone gives the material of growth. And as this nutritive material cannot any where continue to be furnished in excess except where the blood also circulates in excess, we presume that local hyperæmia ministers to the productivity of the part. Accordingly, in the more detailed examination which is now to be made into the facts of inflammatory production, these are the points for separate inquiry;—first, what are the changes of the local circulation; next, what are the changes of the local blastema; last, what are the changes of the local growth.

(a) *Changes in the local circulation.*

Considerable hyperæmia in any part of the body is a fact which can hardly be overlooked; and the hyperæmia which always attends inflammation is so very obvious a phenomenon, that pathologists gave it their first attention. Thirty years ago, it was the common English pathology, that an "altered action of blood-vessels" was the essence of an inflammatory process and accounted for the other phenomena of inflammation. It was not then known, as it is now known, that the relation of blood-vessels to textural growth is merely ministerial. There was a vague notion that the "action" of small blood-vessels built up the tissues in a kind of bricklaying way; and that those vessels, as if by differences of manipulation, could plaster their product into this shape or the other—into bone or muscle, into tubercle or cancer. That tissues are independent of blood-vessels except for the administration of food and the removal of refuse; that they develop and grow by the life of their own germs, and according to the several patterns which they respectively inherit,—this doctrine, now almost universally accepted, has only been possible since the great discovery of Schwann. And so deeply rooted are the old traditions, that, even now, it is not superfluous to consider, though very briefly, what are, so far as we know, the possible "actions" of blood-vessels.

The texture of all blood-vessels—arteries, veins and capillaries, is universally extensible and elastic. Compound in the larger vessels, it is reduced in the capillaries to extreme simplicity and thinness:—consisting in fact of but a single hyaline membrane extremely delicate and, except for its nuclei, homogeneous. The most elaborate studies of this membrane discover in it no trace of its exercising any other than mechanical and physical uses. In health it can allow (indeed it cannot forbid) fluid to sweat through it from the liquor sanguinis to the tissues. It is thus the passive medium of that transudation which ministers to growth. According to circumstances presently to be considered, the transuding fluid may vary in quantity and in quality; but the circumstances which modify it are not primary changes in the membrane; except of course that if the membrane be ruptured or dissolved, normal transudation is at an end, and capillary hæmorrhage takes its place. The membrane cannot contract or relax with any similarity to muscular tissues. It has life enough to sustain itself,—life enough, it may be, when need is, to grow by offshoots and to make new networks of capillary tubing; but here, so far as we know, is the limit of its "action."

The veins and arteries are active organs. In them, besides merely elastic texture, there is well-marked involuntary muscular fibre. And the laws of their contractility are all-important to the pathology of hyperæmia. For the fibres being circularly disposed regulate the calibre of each tube; and thus, theoretically, there is no limit to the influence which may be exerted over the distribution of blood by comparative closure of some channels and consentaneous opening of others.* The muscular substance of arteries and veins contracts under the same common stimulants as provoke contraction in the fibres of the dartos, or of the bladder, or of the intestinal canal. Cold, galvanism and mechanical irritation give familiar illustrations of this.† The surgical use of cold for the purpose of arresting hæmorrhage is founded on its power of causing contraction in unstriped muscular fibre; and the use of friction and galvanism in the treatment of varicose veins is an application of these agencies to stimulate a too indolent muscular contractility. With healthy veins (as, for instance, when the course of the larger visible veins of the forearm is sharply rubbed across through the skin; or when any length of vein is denuded in a surgical operation) the muscular contraction which gives a sort of beadiness to the tube seldom amounts to complete closure. But with the more developed muscularity of arteries this constantly occurs, even in a way to attract popular notice. While drying oneself after a cold bath, it is not uncommon to find that a finger or two is numb, anæmic and shrivelled (*dead* as it is called) from the transient obliteration of digital arteries; and a similar cutting off of the local supply of blood is sometimes produced by a sharp blow on the side of the finger. Here then, it would appear, is the limit of what can be done by the "action" of blood-vessels. The only "action" of which an artery or vein is capable (beyond what relates to its own growth and development) is the action of its muscular substance. That action is *contractility, regulative of calibre.* In proportion as it is heightened the vessel becomes smaller;‡ in proportion as it is lowered, the vessel becomes larger. In other words, an artery by its "increased action" can only effect a lessened access of blood to the parts which it supplies; and an augmented afflux of blood, so far as it depends on the artery, can only depend on that artery being in a state of "diminished action."

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* Take for instance the change which may be produced in the afflux of blood to the brain by a comparative closure of the internal carotid and vertebral arteries, with consentaneous relaxation of arteries (superior and inferior thyroid) which rise next to them respectively. See *Phil. Trans.* 1844.

† The rigidity with which for some time after death arteries resist the entrance of injections is well known to practical anatomists. In the spleen this is wonderfully the case.

‡ Mr. Lister, in his interesting paper *On the Early Stages of Inflammation* (*Phil. Transact. for* 1858, p. 653) states that the fibre-cells of the frog's intestine contract to $\frac{1}{10}$ of their original length.

Now, with reference to the arteries which minister to an inflamed part, it may be anticipated from what has just been said, that their state is the reverse of a constricted one. And such is the fact:—their muscular substance, instead of being contracted, is relaxed; their calibre, in consequence, is more than normally open; they admit an extraordinary profusion of blood. By their increased dimensions, and by their fulness of coloured contents, they become unusually visible. In the inflaming conjunctiva, for instance, this may be well observed:—vessels which before were unseen start into sight; those which were already perceptible, become sensibly larger; and the whole part gradually reddens, partly with a network of these distinguishable vessels, partly with an uniform blush, which—though the naked eye cannot resolve it into its component parts, is known to depend on a similar enlargement and congestion of innumerable smaller vessels.*

This enlargement and filling of vessels is not only arterial. Any one who observes an inflamed part can see that its veins, like its arteries, are large and full. Presently there will appear good reason for believing that even this large venous efflux does not equal the arterial afflux of blood,—that it leaves more and more stagnation behind it in the part. But, as compared with health, the venous flow is greatly increased; so that, whatever congestion there may be in the part, there is also increased circulation through it.†

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* See John Hunter; Works, ed. 1837, vol. iii. pp. 322-3. "Parts inflamed, when compared with similar parts not inflamed, show a considerable difference in the size of the vessels, and probably from this cause bring an increased number to view. I froze the ear of a rabbit and thawed it again; this excited a considerable inflammation, an increased heat, and a considerable thickening of the part. This rabbit was killed when the ear was in the height of inflammation, and the head being injected, the two ears were removed and dried. The uninflamed ear dried clear and transparent, the vessels were distinctly seen ramifying through the substance; but the inflamed ear dried thicker and more opake, and its arteries were considerably larger."

† See Hunter again; lib. cit. p. 201. "It is curious to observe how vessels become enlarged upon any irritation, not only the arteries, but the veins, and not only the smaller branches, but the larger trunks. This was evident in the following case: I applied a caustic to the ball of the great toe of a patient every other day for more than a month, and after each application the surrounding parts put on a blush, and all the veins on the top of the

This hyperæmia invariably attends inflammation, and is essential to the inflammatory process. But it is not peculiar to parts which are inflamed. It goes with all forms of increased nutritive activity. "Vessels (says John Hunter) have a power of increase within themselves . . . . which is *according to the necessity*, whether natural or diseased:"—thus it is, that the carotid vessels of the stag enlarge with the growth of horn, that the spermatic vessels of cock-birds enlarge with the vernal excitement of the testicle, that the uterine vessels of mammalia enlarge with the process of pregnancy, that vessels any where in the body enlarge with the development of tumours which they supply. And no doubt in all these cases, just as in inflammation, the part through which the flow of blood is increased is also, notwithstanding its greater outflow, especially retentive of blood.

Something more will hereafter be said of the powers which are concerned in producing these so-called local *determinations of blood.* All that needs now be remarked is, that, though indispensable to the nutritive changes which are going on, they can only be regarded as ministerial to those changes, not as their exciting causes. Hyperæmia, as abundant as ever exists in inflammation, can go on for months without producing textural change,—without causing a single pus-cell to grow, or a single texture-germ to die.*

A part does not inflame because it receives more blood. It receives more blood because it is inflamed. "Action (says John Hunter) creates the necessity for support, and supplies it." How this is effected needs not now be discussed. Simply let it be recognised that, with the greater necessities of a part, all required blood-supply comes to it; and that the enlargement of blood-vessels which permits this afflux is due, not to any mechanism acting *a tergo*, but to an influence primarily exerted by the part.

Nothing can better illustrate the meaning of this distinction than the contrast (on which the late Dr. John Reid insisted) of a case in which the femoral artery has been obliterated for aneurism with one in which amputation of the thigh has been performed:—in both cases the main artery is obliterated, and at about the same spot; in both cases the pressure of the heart's action is the same; but in one case, there remains no requirement for blood below the place

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foot, as well as up the leg, immediately began to swell, and became large and full. This was so remarkable that the patient watched for this effect on the days on which the caustic was applied, from its happening only on those days."

* Witness M. Bernard's experiments on the circulation in the external ear after division of the cervical sympathetic.

of ligature, and accordingly the collateral blood-vessels undergo no enlargement; whereas in the other case, the entire remaining limb requires its customary supply of blood, and the collateral blood-vessels accordingly enlarge so amply that not an hour's anæmia is inflicted on it. And to the same effect is the argument of Prof. Virchow (supported by a curious experiment of his own, as well as by many recorded cases of disease and malformation) that, when a pulmonary artery is obstructed, the lung gets its compensative supply through arteries—bronchial and intercostal, belonging to the aortic system.

What is it, then, in these cases, that opens a way for collateral circulation, through the profunda femoris in the one case, through the bronchial and intercostal arteries in the other? Evidently not increased pressure by the heart, but diminished resistance by the artery. And thus no doubt it is with the hyperæmia of inflammation, and of other nutritive activities.

It is of course only with the aid of the microscope, and therefore never during life in the human body, that observations can be made as to the state of the capillary circulation in inflamed parts. That in most considerable inflammations of vascular textures there is more or less destruction of capillary blood-vessels is a fact which may be ascertained in the course of common clinical and post-mortem observation;* but the minute circulatory changes which belong to the first onset of inflammation can only be learnt from experiments in the lower animals—best of all, by observing the phenomena which result when some mild irritant is applied to the web of the frog's foot. Every one who has watched in this transparent part the beautiful phenomena of healthy circulation knows that, naturally, in the capillaries, the corpuscles of the blood do not seem uniformly diffused in the liquor sanguinis, but flow in a comparatively dense series in the middle of each current, and that the marginal parts of the stream consist of liquor sanguinis almost entirely without corpuscles. When the web is artificially irritated (as for instance, by a little capsicum or mustard placed on it near its free margin) the blood within the capillaries of the affected area is observed gradually to lose that characteristic appearance:—the central stream of blood-corpuscles becomes wider; the marginal stream of liquor sanguinis becomes narrower; the whole stream gets to look (what the mid-stream only ought to look) chiefly corpuscular. With this seeming change in the local constitution of the blood, there has arisen also a change in its rate of movement;—for a moment, at the first impression of the irritant, the blood seemed to run more quickly; but in proportion as the stream has become corpuscular, it has become slow. The changes still advance;—capillary streams, looking densely and redly corpuscular, are seen moving in the most sluggish and interrupted manner, till eventually stagnation arises. The corpuscles are now so packed together that individual forms are no longer distinguishable. Groups of capillaries, thus plugged by motionless, solid-seeming contents, look as though they were converted into a non-tubular coralline network:—and this is the state which, since it was first pointed out some forty years ago, has been familiarly known to pathological observers as the capillary "stasis" producible by irritation.

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* In the course of these destructive changes the small vessels, with softening walls, admit of being considerably distended from their natural sizes and forms, so that sometimes they are found with remarkable ampullations and deformities. See Hasse and Kölliker in Henle and Pfeuffer's *Zeitschr.* vol. iv.

Our knowledge of these phenomena is derived almost exclusively from experiments performed on the web of the frog's foot; but there are good reasons for believing that the capillary circulation of inflamed parts in mammals presents quite similar changes. And the knowledge, such as it is, may be summed up in the following conclusions:—

that within the area of stasis the blood has lost the fluid in which its corpuscles should float;

that within the same area the circulation of corpuscles is delayed,—the corpuscles tending to rest against the wall of their containing capillary, and tending also to aggregate there as though by mutual cohesiveness;

that though the corpuscles, when thus in situ, show a morbid cohesiveness, they do not, when removed from the area of stasis, seem more cohesive than in blood taken from healthy parts;*

that the circumstances under which inflammatory stasis occurs are circumstances under which there is increased infiltration of the contiguous textures, and that stasis occurs with more or less facility in proportion as the liquor sanguinis is more or less transudable;†

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* This point is well established by Mr. Lister in his paper *On the Early Stages of Inflammation*, loc. cit. p. 669.

† Dr. Schuler's experiments on this subject are of great pathological value. They are published in extenso in Canstatt's *Jahresbericht* for 1854, ii. p. 101. Having first found that by applying a certain solution of nitre (17 in 100) he could produce stasis in ten minutes (by stronger solutions

that stasis does not result from alteration of calibre in the afferent or efferent vessels of the part;

that the cause of its production lies wholly in an influence exerted on the blood by textures within the area of stasis,—for it may be produced in the webs of limbs which, by strangulation or even by amputation, are cut off from all dependence on the general system;

that this influence is, mechanically speaking, of a suctional kind,—for when irritation-experiments are performed on the webs of a strangulated limb, the corpuscles can be seen gathering from

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more quickly, and by weaker solutions less quickly) he began to try with what differences of rapidity he could produce stasis, if first he had made some artificial modification of the animal's blood. These modifications he made, sometimes by dilutive, sometimes by inspissative, proceedings:—abstractions of blood, and injections either of water or of very weak saline solutions, being used for the former purpose; injections of strong saline solutions for the latter. By these means, he succeeded in establishing (1) that, if the transudability of the liquor sanguinis were increased by dilution, an irritant weaker than the standard would produce stasis within the standard time; and (2) that, if the transudability of the liquor sanguinis were diminished by concentration, reverse effects were obtained. The following short summary of his experiments will enable the reader to estimate their bearing on the argument stated in our text:

Nature and strength of material used as irritant.	Experimental modification of blood.	No. of minutes in which stasis was produced.
Solution of nitre, standard 17 per cent.	none	10
17 per cent	inj. 6 per cent solut. of nitre	5
10 ,, ,,	,, ,, ,, ,, ,,	10
6 ,, ,,	inj. of water ʒj.	8
8 ,, ,,	,, ,, ,,	10
15 ,, ,,	inj. of water in very small quantity	9
10 ,, ,,	large hæmorrhage	9
10 ,, ,,	,, ,, ,,	13
15 ,, ,,	small hæmorrhage	10
10 ,, ,,	repeated hæmorrhage	10
26 ,, ,,	inj. 35 per cent sol. chl. sod.	12
20 ,, ,,	inj. 24 per cent sol. nitre	not within 20
Ol. sinap. æther. gtt. viij c. alcohol. gr. xl.	before and after inj. ʒj. water	9 and 4
	before and after inj. 6 per cent nitre	10 ,, 6
	,, ,, ,, ,, ,, ,,	7 ,, 4

both directions (arterial and venous) towards the area where stasis is being developed;*

that this influence is but different in degree from that which the textures naturally exercise on the blood as it passes amid them; for, if a limb be temporarily strangulated, there arises in its webs within 4-8 hours, without any irritant being applied, a stasis, which is identical with inflammatory stasis, except that, even after 60 hours' duration, it will be dissipated as soon as the circulation is set free.†

Among the most important incidents of active hyperæmia, especially as it occurs in inflammation, is to be counted the frequent formation of new channels for the blood. This fact will be considered in detail, when the processes of ADHESION and GRANULATION are being described.

But, before closing the present section, a word more may be said of the doctrine, which many of the above-stated facts contribute to establish,—that the phenomena of inflammatory turgescence are primarily the result of an increased *attraction* which the inflaming tissue exerts, as it were suctionally, on the blood coursing within its capillaries. This doctrine is not new;‡ though without some of the facts which have here been stated, its basis could hardly be considered secure. And in the present stage of our argument it is without the support which will hereafter be given it by a statement of those parenchymatous changes which proceed side by side with the vascular turgescence. Still, even now, it may be considered proven. And, to persons who are informed in vegetable physiology, it will certainly not seem strange. For in the vegetable kingdom that sort of attraction is a sufficiently familiar fact. It is thus that certain vegetable textures are able, when irritated, to undergo such changes of dimension as determine, for instance, the definite movements of the berberis and the mimosa. Thus likewise it is, that, under the partial application of stimulants to sections of the vegetable organism, partial growth-phenomena are initiated, and, as it were, hypertrophically sustained :—the southward side of a tree will have ripe fruit even while its northward side is still flowering ;* and "if in the winter-time, the branch of a vine be introduced into a hot-house, it will produce a luxuriant crop of leaves, blossom and fruit, even during a frost, in which situation the roots would have been in a torpid state, had it not been for the sympathetic influence of the parts above ground, brought into action by warmth."† If in the vegetable organism, where neither nerves nor contractile blood-vessels exist, local derivations of fluid are to this extent possible, there is no reason to wonder that similar derivations are, in the animal organism, primarily independent of vascular innervation or vascular contractility. "The growing elements of the part, hurt by physical violence, or affected by extremes of temperature, or thrown

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* Experiments, as described in the text, were first performed by Dr. H. Weber of Giessen, and were, with many other important contributions to the subject, made known in his paper on stasis in Müller's *Archiv*, 1852; but the fact that corpuscles converge towards the area of stasis, "almost as though there were a vortex established in the place of the irritant," had already been observed.

† This fact was established by Dr. H. Weber in the paper just referred to.

‡ The physiological views which (as to the normal relations of blood and tissue) are identified with that doctrine, were probably entertained by Haller. Prochaska in various places showed that they were his:—see especially in *Quest. Physiolog.*, edit. 1778, p. 17: "Quod attractio inter humores nostros et inter solida nostra quæcunque aliqua sit, nemo erit qui non ex quotidianâ fere experientiâ convictus sit." Hebenstreit (*De Turgore Vitali*, edit. 1795, p. 25) in speaking of inflammatory turgescence, says, nature has so constructed the vessels and the membranes of cellular texture, that, under the action of irritants, "irritamenti sibi allati obscuro quodam sensu ad explicandum sese et expandendum instigentur. Igitur si ad partes exstimulatas sanguis aliique humores confluunt, id ipsum, meâ quidem sententiâ, non principium distensionis est, sed effectus necessarius: hoc est non ea propter vasa cellulæque distenduntur, quoniam ab advectis humoribus impelluntur et cedere coguntur; sed quia sese explicant, idcirco nimirum humores adventantes recipiunt." Burdach's teaching (*Physiol.* iv. p. 422) was to the same effect: "Die Turgescenz geht nicht von den Gefässen, sondern von den ausserhalb derselben liegenden Gebilden aus;" and language can hardly be more graphic than that in which he expresses (lib. cit. p. 410) his general view of the relations between texture and blood-

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vessels : "So sind denn die Adern nichts anderes als die bleibende Spur der ursprünglichen Bewegung—der beharrliche Ausdruck der Beziehung des Blutes zu den verschiedenen organischen Theilen." The late Professor Alison probably entertained similar views :—in 1833 (*Outlines of Physiol. and Path.* pp. 428-441) he taught it as "highly probable, that the primary and fundamental change in inflammation is not in the vital contractions of vessels, but in the vital affinities subsisting between the component parts of the blood, and between them and the surrounding textures ;" but in a later work (*Outl. of Path. and Pract. of Med.* 1844, p. 108-129) though adhering generally to this formula, he laid especial stress on what he now apparently believed to be a more important power than any textural attraction : "the afflux of blood to the inflamed part, its stagnation there, and the most important of the changes which it undergoes are included in this general proposition, that the fibrin contained in the blood in that part of the body is affected during the state of inflammation with the same change of property to which, when we see it in the fibrin that constitutes the bulk of muscular fibres, we give the name of rigidity or tonic spasm."

* See the *Times*, Oct. 23, 1834.

† Blane's *Medical Logic*, 3d ed. p. 154.

into rapid chemical changes, or overburthened with their own specific stimuli from the blood—strive to grow more, or to grow otherwise, than in their previous state. The sudden origination of this effort [acting at first independently of the vital endowments of the artery,—acting as though a vortex, established in place of the irritant, were causing all streamlets of blood more quickly to approach and more slowly to leave it] suffices apparently in itself to derange the currents of the capillary circulation, to flood the tissue with serous exudation, and to lead to those microscopical phenomena [of stasis] which are considered pathognomonic of inflammation." But for the animal texture, it is an essential, though a second step in the process, that, in consent with these primary changes, the arteries of the irritated part relax their muscular tone and admit a larger afflux of blood. What is the channel of influence for determining this sympathetic phenomenon? Possibly, but not necessarily, it is nervous. When capillaries lose, as though by extrinsic suction, a portion of their fluid contents,—when spaces of capillary network are obstructed by the stasis of corpuscles, differences of tension, equivalent to differences of contact, must be experienced by those ultimate arterial branchings which are in nearest relation with the derangement. That these—as it were, *contactual* impressions on the artery occasion its changes of calibre, may be regarded as in the highest degree probable. But whether directly or indirectly, must at present remain uncertain;—whether, namely, the impression and influence proceed continuously from element to element along the contractile arterial texture, or, on the contrary, be centripetal and reflectible, and require nerve-fibrils and ganglion for their propagation.

(b) *Changes in the local blastema.*

Every surgical student must have noticed how apt is an inflamed part to be more than commonly juicy. He has seen synovial and serous sacs, when inflamed, fill themselves with pale fluid. He has seen such fluid as the contents of a blister. He has seen it as the main element of swelling, in parts which become "œdematous" with inflammation. He has seen it drain away, after hæmorrhage has ceased, from the cuts or punctures made into inflamed cellular membrane—as, for instance, in erysipelas. He has seen the dressings of a stump, within the first two days from amputation, soaked through and through with the same sort of drainage. He has seen an inflamed mucous membrane—that of the bowels during cholera, or that of the eyes and nose during common cold in the head, overflow with the same liquidity of product. And even among the ordinary phenomena of suppuration (though here, it may seem, there are more complex conditions to be spoken of) the fact of fluid discharge stands out as the broad characteristic.

What, then, is the meaning of this greater juiciness of an inflamed part? It is an exaggeration of that natural moistening of the tissues which is necessary for their nourishment,—an exaggeration in respect of quantity, and also (if the phrase may be allowed) an exaggeration in respect of quality.

The fluid which naturally sweats through the wall of the capillary blood-vessels, and ministers to the nutrition of texture, is of course* in general chemical correspondence with the liquor sanguinis from which it emanates, but differs from the parent fluid in containing very much less dissolved matter. For (as Professor Lehmann states the case) animal membrane being much more transudable by the water of the blood than by its salts, and more transudable by its salts than by its albumen, the quality of the normal transudation is fixed by these physical conditions. It is colourless, transparent, alkaline and of faintly-saltish taste; it contains no shaped constituents, and its specific gravity is but little above that of water. In cases of venous obstruction, where this transudation takes place under more than normal cardiac pressure, we find that the fluid, besides increasing in quantity (so as to constitute the well-known phenomenon of passive dropsy) presents certain changes of quality —changes, which, in proportion as the pressure is great, bring it nearer and nearer to the characters of liquor sanguinis. It gets to contain more and more albumen; it even furnishes a fibrinous coagulum. Still it preserves its essential character,—that of containing only elements of the liquor sanguinis, and containing them all in less proportion than that wherewith they are contained in the blood. But in extreme cases the apparatus of transudation becomes destroyed:*—the distended capillaries burst, and filtration gives place to hæmorrhage.

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* This is inference, not observation. For the natural blastema of textures cannot be obtained apart from them in quantity which admits of analysis, and our means of judging what it is are founded, partly on filtration-experiments performed under various circumstances with animal membranes and serum, and partly on observation of cases where the natural exudation has become more abundant under influences of a mechanical kind. Carefully-selected instances of passive dropsy, arranged in a series according to the amount of pressure under which (*cæt. par.*) the fluid has been effused, are the safest indications towards what, at present, can only be an approximation to knowledge of the normal *transudatum* of the blood. Lehmann (perhaps not wisely) lets much of his doctrine rest on the qualities of the cerebro-spinal fluid, the liquor amnii, and the aqueous humour;—fluids which, though they fulfil merely mechanical uses, are not of identical composition.

The so-called "effusions" of inflammation—whether they be serous or purulent, whether they come from shut sacs, or from blisters, or from œdematous cellular membrane, or from abscesses, present the characteristics of a blastema which has transuded under more than normal pressure, or with less than normal resistance. Their specific gravity is high. Their proportion of albumen is great. And, where they are not purulent, they commonly give a fibrinous coagulum. Often too they contain evidence that capillary blood-vessels have given way,—products of hæmorrhage being mixed, in greater or less quantity, with the products of increased exudation. So that, up to a certain point, the fluids of inflammation are such as might be plausibly accounted for, on physical principles, by referring to the enlarged arteries, the softening capillaries, and the retarded circulation of the inflamed texture.

But there are two essential characteristics of inflammatory effusion,—characteristics which absolutely distinguish this effusion from that of obstructional dropsies,—characteristics which cannot be due to any mechanical influence. In the first place, the inflammatory effusion tends to contain certain ingredients in larger proportion than that in which they exist in the blood. In the second place, the inflammatory effusion teems with organic forms.

The great chemical characteristic of inflammatory effusions is their excess of chloride of sodium and of phosphates. Pus (says Prof. Lehmann) contains three times as much chloride of sodium as the serum of the blood: and during pneumonia (as Dr. Beale† has shown) the lung is so disproportionately loaded with this salt, that the urine is entirely deprived of it: while as regards the phosphates, Prof. Lehmann states that even the thin bloodless weeping of wounds furnishes a fluid more highly phosphatised than the liquor sanguinis. And the value of these facts, in reference to our present subject, may be inferred from a knowledge of the circumstances under which, apart from inflammation, these ingredients generally abound. "Everywhere, even in the lowest forms of life where the organism is poor in such salts, everywhere (says Prof. Lehmann) where cells and fibres grow, the phosphates sensibly accumulate. And from the most vitalised textures—from muscle, for instance, where material is most actively renewed, the blood returns greatly more dephosphatised than that which returns from less active organs." So with the other preponderant salt:—"for (says Dr. Beale) from the analyses of various observers, it appears that a large quantity of chloride of sodium is present whenever the metamorphosis of tissues depending upon cell-development is going on."

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* See Dr. Robinson's experiments on the effects of obstructing the renal circulation; *Med.-Chir. Trans.* vol. xxvi.

† *Med.-Chir. Transact.* vol. xxxv.

In accordance with these chemical characteristics is the microscopical one which has been mentioned,—that inflammatory effusions abound with living organic forms. Not indeed all such effusions equally:—for, on the one hand, pus is so densely corpusculated that it seems under the microscope to consist of little but cells, and has on this account sometimes been figuratively spoken of as mere "unsolid texture;" while on the other hand, in many non-purulent effusions, the water so greatly preponderates that cells are scarcely seen unless searched for. But whether more or less abundant, universally, where there is inflammatory effusion, characteristic cells are to be found,—cells of which the pus-cell is the type. Up to that type there are visible stages of development, and from that type there are visible stages of degeneration;—on the one hand immaturities, on the other hand senilities, of the product;—the former chiefly represented by cytoblasts and by cells so small that the distinction of nucleus and cell-membrane is only just distinguishable in them; the latter chiefly represented by cells which become larger and more filled with oil-drops in proportion as they become ready for dissolution. The typical form, thus approached and thus departed from, is a thin-walled globule of about $\frac{1}{2000}$ of an inch in diameter, pellucid, containing some semi-fluid albuminous matter, and possessing a compound or simple nucleus, which is best seen when the microscopical specimen is slowly acted on by water, or very diluted acetic acid. This cell is insusceptible of ulterior development. It may remain long stationary, but it cannot contribute to tissue. It can only degenerate and decay. And its morphological meaning assuredly is, that it represents the miscarriage of what was intended to be texture. The local germination has been excessive, and (in proportion to various circumstances which will hereafter be considered) parts of it digress into this sterile course of development.

These, then, generally are the changes which characterise the blastema of an inflamed part:—1) it is in most cases demonstrably, in other cases presumably, increased in quantity; 2) it contains far more solid matter, both albuminous and saline, than is normal to it;—and besides presenting these features, which may to some extent be attributed to mechanical influences, it gives evidence, by the chemical and microscopical characters which have last been described, 3) that specific chemical affinities are exerted in the part, and 4) that abnormal growth is advancing there.

Different inflammatory effusions have, however, their special differences. In some there is a great yield of fibrin:—it is distinctive, for instance, of the exudation in diphtheria that, by virtue of this quality, it concretes upon the affected surface in the form of the firm false-membrane from which the disease derives its name: while in some other effusions (and this generally speaking is characteristic of well-formed pus) there is no attempt even at partial coagulation. And primary differences of fluidity are noticeable:—compare, for instance, the products of pleurisy or cholera with those of ostitis or muscular rheumatism. Moreover, there are differences (not strictly belonging to the present section of the subject) due to the degree in which the detritus of dead and disintegrating tissue mingles itself with the inflammatory effusion. And not least there are differences due to the different degrees in which the effusion itself may have undergone degenerative changes;—for the products of inflammation, shaped and unshaped, cellular and fibrinous, are apt to degenerate by the same sort of process as belongs to the decay of other albuminous material; and in proportion as these degenerations occur, the original characters of the effusion give place to others, among which may particularly be mentioned the presence of oil or cholesterine, and eventually of earthy concretions.

Of the source and significance of that corpuscularity which has been mentioned as essential to inflammatory effusions, something will be said in the next section.

(c) *Changes in the textural elements themselves.*

Scarcely any part of the study of inflammation is of more pathological interest than that which relates to the evidences of increased productivity which are furnished by the inflamed texture itself. The microscopist, confining his inquiry to the centre of any sphere of inflammation, observes, if the inflammation be severe, that but little or no trace of texture is remaining. Nor does he find aught which he, without preparatory knowledge, would recognise to be representative of increased textural growth. But if, instead of thus limiting his inquiry, he begin it with specimens taken at some distance from the centre of disease—still better, if he begin it just beyond the limits of the local excitement, and gradually extend his analysis from healthy to inflamed texture, comparing together what is normal and what is commencingly abnormal, he will find (and this all the more in proportion as his examination is minute) that he is amid the most wonderful scene of textural development. Outside the central slush of gangrene or abscess—outside what for the moment may be regarded as mere pathological confusion, he can trace the orderly commencement of changes which have that apparent confusion for their result. Farthest from the focus of inflammation and unparticipating in its excitement, there lie before him the nuclei of healthy texture, living their common life:—nearer to the morbid influence, he sees this germinal material growing according to its type, and by subdivision becoming prolific;—nearer still, he sees, at first sparsely, afterwards in overwhelming abundance, those various organic forms (hitherto unexplained) which characterise inflammatory effusion; and, little by little, he comes to learn that these organic forms, having the pus-cell for their type, are derivatives of textural over-growth—of an over-growth in which the textural germs have multiplied to excess, and the intercellular material is absent. Combined with those forms, or in their stead, he sees other textural elements, which, during simple hypertrophy, have been overtaken by death and degeneration; and beside them all, of course, he sees those other textural changes which have been described as appurtenant to inflammation—the changes of mere death and decay. But less by the latter than by the former signs—less by seeing mere gangrenised texture amid the produced pus, than by interpreting the pus-production itself, and by interpreting the textural concurrence of hypertrophy and degeneration, he learns what hitherto unavoidably has been left unsaid,—that the two great factors of inflammation, increased production and increased death, are not only to be seen asunder in different compartments of the area of disease, but are to be seen jointly expressed in single textural forms. In the outer zones of inflammatory excitement, it is mere hypertrophy which is seen. But step by step towards the centre we can trace this hypertrophy gradually succumbing, in one of two forms, to the stronger influence of death;—succumbing to it during transition, so that recognisable textural forms, over-multiplied and overgrown, are found in act of degeneration and decay among other dissolving material;—or succumbing to it, by way of abortion, in the sterile finality of pus. For though hitherto we have spoken of suppuration as a fact of inflammatory over-productiveness, yet here the truth must be added, that, in this over-productiveness, nature is cheated of her intent; since the subdividing germinal material, wherever its excitement is highest, becomes incapable of ripening into texture. At a certain moment in the process (a moment which for nature no doubt is perfectly definite, but by us cannot be defined) with a certain intensity of reproduction, the germs can only abort. Myriads of them, gathered together towards the mid-focus of excitement, gathered there in the tumult of their multiplication, incoherent monads, uncontributive to texture, each, as fast as it can absorb fluid enough, puts forth a cell-membrane about itself. It is then the "nucleus"—and according to the moment of subdivision at which its individual career is thus accomplished, the single, or bifid, or trifid, or quadrifid nucleus, of a pus-cell. And for that pus-cell there is no fruitful result. Essentially final as regards all manifestations of life, it now can only decay. Where it is the product of an exterior part—of an open sore, of a mucous membrane, of an abscess, we recognise its deciduous character. It is shed as though it were a slough. Where this is not the case, the cell slowly degenerates within the body by processes which already have been described.

Such, summarily stated, is the knowledge which late years have given us of the morphology of inflammation. To discuss its details with minuteness proportionate to their pathological interest, would be unsuitable to this occasion: yet without very minute discussion, it is difficult to convey more precise knowledge than is in that very general statement. If the writer, instead of pointing especially to the growth and multiplication of nuclear material, had directed attention chiefly to cell-membranes and cell-contents, he would have had to speak with much more hesitation, and to propose many debatable questions. On the whole he has thought it better to confine himself to that aspect of the case, respecting which there prevail no important differences of opinion, and in which, notwithstanding its generality, the essential law is best expressed,—that *the cell-forms of inflammation are derivatives of the cell-forms of health.* For all purposes of the present argument, it is enough to know that the textural effect of a stimulus is increased textural germination; that certain earlier products of this "irritative hypertrophy," perishing amid their development, furnish one type of inflammatory cell-form—that in which the textural element, recognisable though unripe, is found undergoing degeneration; while later successions of the same germinal act furnish that other type of inflammatory production, where pus-cells, innumerable but sterile, express one common abortion of tumultuous textural overgrowth.

Illustrations of the above general statement may be found in various textures; best of all in those which are least vascular.

For instance—in the so-called ulceration of articular cartilage, the student will find perfect cases of the first-mentioned type. He will find (as was well shown ten years ago in Dr. Peter Redfern's very meritorious work* on the subject) that, throughout some thickness of substance beneath the erosion, the characteristic endogeny of cartilage-cells is increased,—in the remoter parts to a less extent, in the nearer parts to a greater extent; so that while in the former direction the observer chiefly sees cells with dividing nuclei and cells containing a first generation of two or three younger cells, in the latter direction he sees a far more advanced productivity—mother-cells containing numerous younger like cells (probably successive generations) or, more commonly, having dozens of nuclei within them and forms indistinguishable from those of pus.† And, in nearing the ulcer, he finds that, on these more striking signs of excited development, signs of degeneration are superinduced. The material becomes greasy and diffluent. Great parturient mother-cells, with their contained broods of young, lie in the floor of the ulcer undergoing death and deliquescence. Oil-drops and detritus are mixed with these decaying forms.

Equally good illustrations of the process may be found in the inflamed cornea (where Dr. Strube‡ began, and Dr. His§ most admirably completed the description of them) and in inflamed tendon. And these structures are in some respects even more instructive than cartilage for the purpose.

When inflamed cornea is examined with low powers of the microscope, the fine laminative, and still finer reticular markings which naturally belong to the structure (and which denote the relations of cellular to intercellular material) are seen exaggerated into a comparatively coarse network,—the ordinary cell-forms of the part, now over-grown and over-gestative. When the details of this structure are investigated with higher powers of the microscope, we find instead of the naturally shrivelled tenuity of corneal cells, numbers of long pouch-like bodies, with irregular communicating offshoots; we find that, within these transformed cells and their branches, there are younger generations of growth—cells more or less closely packed, and with nuclei more or less actively subdividing; that the younger cells, as they get, in descent or in position, more remote from the parent form, show more and more nuclear subdivision; till swarms of them, of uniform size, of simple globularity, and with multifid nuclei, answer to every familiar character of the pus-cell. Here, as with cartilage, the hypertrophy may be traced in successive stages of increase from remoter to more affected points; and here also towards the focus of irritation we find the overgrown forms beginning to degenerate by the ordinary process of decay.

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* *Anormal Nutrition in the Human Articular Cartilages, with experimental researches on the lower animals; Monthly Journal of Medical Sciences*, 1849-50; reprinted (Edinburgh) 1850.

† Dr. Redfern believed that cartilage could not suppurate. The contrary is well shown in a paper by Prof. C. O. Weber, in Virchow's *Archiv*, vol. xiii.

‡ *Der normale Bau der Cornea und die patholog. Abweichungen in demselben;* Würzburg, 1851.

§ *Beiträge zur norm. u. patholog. Histologie der Cornea;* Basel, 1856.

When tendon inflames, very similar appearances are seen. The little cuminiform bodies of healthy tendon, naturally so slender and so few that (even after the action of acetic acid) a microscopist may easily overlook them, have given place, by gradual transformation, to long coarse tracts of material, opaque with an immensity of endogenous growth. And here again the steps of change may be traced in different parts of any one specimen, from the first enlargement and germination of the original corpuscle (the cell-membrane of which now becomes distinct) to a stage where the ulterior divisions of nuclear material furnish germs which can no longer be distinguished from those of fluid pus. In some of the drawings published by Professor C. Otto Weber (to whom belongs the principal merit of conclusively establishing* the textural origin of pus) the enlarged corpuscles of inflamed periosteum are represented, hanging together in plexuses of considerable extent, somewhat in the style of Turkish coin-necklaces, but with long tubular communications, and exhibiting contained pus-formation in every stage of its progress.

Not less instructive, for our present object, is the study of epitheliated membranes.

It is no new thought that, when mucous membranes suppurate, the formation of pus represents what should have been the germination of epithelium; that, in respect of this substitution, the tissue which should have borne epithelium must be regarded as the mother-tissue of pus; and that, even "between the pus-globule and the healthy gland-cell," glandular inflammation gives a "series of connecting forms." But it is only of late, that precise information has been acquired on the details of this subject,—information which enables us definitely to say that membranes suppurate, as cartilage or tendon suppurates, by profuse endogeny within the natural elements of texture. The process has been minutely followed in the urinary mucous membrane by Dr. G. Burckhart;* who, having first established that the natural mother-tissue of this epithelium is the dermoid tissue beneath it, and not any intervening limitary membrane, proceeds to show, that, when the membrane is inflamed, the corpuscles of that dermoid tissue begin to grow and multiply, after the plan already described in other textures, and that pus-corpuscles, as well as the many shapes of so-called mucus-corpuscle, are the various manifestations of this endogeny. On this showing, it can excite no wonder that the mucus-corpuscle, like the pus-cell, often has a multifid nucleus; a fact, which may be verified in most catarrhal discharges; and which entitles us, in the absence of other equally exact observations, to infer that what Dr. Burckhart has minutely followed with the urethra, is, in substance, equally true of other mucous membranes. Among the illustrations of Dr. Biermer's essay on expectoration,† are some which, in this point of view, are very interesting;—sometimes an aborted bronchial epithelium, columnar, but without cilia, and having even three nuclei in its length; sometimes epithelium, duly ciliated, but again having this multiplication of its nuclei; and in one case an approaching consummation of this process — a very prolonged columnar cell, ciliated and normally shaped at one end, but having two nuclei, and beginning to divide itself transversely by a narrow constriction between them.

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* See his most admirable paper—*Zur Entwickelungsgeschichte des Eiters*, in Virchow's *Archiv*, vol. xv. Dec. 1858.

The generation of shaped inflammatory products by serous and synovial membranes appears to be on precisely the same plan as that which has here been described in respect of mucous membranes.

How it is that textural growth, as a constituent of inflammation, becomes the agent of textural repair; how it effects adhesion between injured surfaces; how it fills up cavities by granulation; how, by cicatrix, if not by true restoration, it compensates for material which has been lost; how new vessels are made, and new nerves;—these are matters which, so far as they belong to surgery, will be discussed in such other parts of the present work as relate to WOUNDS, ABSCESSES, and ULCERS.

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* See his carefully-worked paper — *Das Epithelium der ableitenden Harnwege*, in Virchow's *Archiv*, vol. xvii. 1859.

† *Die Lehre vom Auswurf;* Würzburg, 1855.

B. THE SYMPTOMS OF INFLAMMATION.

That inflammation is denoted by "redness and swelling with heat and pain," was the teaching of Celsus some eighteen centuries ago. Subject to a somewhat more free interpretation than perhaps he would have given to his words, the statement may still be accepted as true. And there can be no more convenient way of discussing the symptoms of inflammation than to analyse that celebrated formula; remembering of course that it purports to describe only what is common to all inflammations, and that such symptoms as are special to particular inflamed organs will remain for subsequent study.

Redness necessarily accompanies inflammation;—redness, seen during life, if the inflamed part be one which we inspect from without;—but, at any rate, redness which the anatomist can discover in the dead body. And the redness here meant is not a fixed blot of colour, but a redness which during life vanishes when the part is pressed upon, and almost instantly returns when this pressure is removed. It is the expression of that hyperæmial state which excitement of texture invariably produces. The part is over-coloured, because it is overfull of blood. The ministerial blood-vessels, relaxing their muscular tone, have admitted into their canals more than the ordinary flow of contents; and wherever there is stasis in the capillaries, the colouring elements of this blood are clustered with comparative concentration. Also in many cases, as inflammation proceeds, new blood-vessels develop themselves and, like the old ones, become filled with blood.

Accidentally in many inflammations, there will be added to these necessary sources of increased redness, the further colouring of hæmorrhage; for often the distended and softened capillaries break with the impulse of the circulation, and let more or less blood extravasate itself into the inflamed part. Such spots of hæmorrhage, if they admit of being observed during life, can be distinguished from the redness which is essential to inflammation by the fact, that, while the latter disappears under the pressure of the finger, the hæmorrhagic spots remain stationary.

The redness of inflammation varies in degree and in tint. The intensity of red represents the quantity of blood which is in the part. The quality of red, on the other hand, represents the rate of the local circulation. The tint shades from scarlet to purple, in proportion as the blood, moving more slowly through the part, acquires a more venous complexion; and the quality of redness is therefore notably a sign of the quality of the local process,—the more active inflammation having the brighter red, the more chronic inflammation tending to dark and livid.

Redness due to vascular fulness must accompany inflammation. But it is not in itself a sufficient sign of inflammation; for such redness may be the result of venous obstruction,—as we see in the suffused tumid face of a person suffering from dyspnœa. Nor, even when due to arterial expansion, is it necessarily the evidence of inflammation; for every hypertrophic process suffices, like inflammation, to determine an increased supply of blood to the part; and the redness of active hyperæmia is, for instance, as well marked in the uterus during gestation as it would be if the uterus were inflamed.

In all ordinary cases, the local maximum of redness is conterminous with the local maximum of textural excitement;—where there is most of the inflammation, there is most of the redness. But there are cases where this cannot be. With what are called extravascular tissues—tissues which, like cornea and cartilage, are not naturally permeated by blood-vessels, but are nourished by (comparatively speaking) long reaches of imbibition from their ministerial blood-vessels, the maximum of redness will be where these blood-vessels have their capillary plexus. Thus, when the cornea is wounded at its centre and begins to inflame at the injured spot, it is not there, but in the surrounding conjunctiva, that we look for the redness which attends inflammation; for here is the medium through which the cornea in health depends on the circulatory system; and here consequently it is that, when the cornea is inflamed, those vascular changes occur, which minister to the act of inflammation.

Swelling in inflammation results partly from the greater abundance of blood which is in the vessels of the inflamed tissue. But mainly it results from the excess of exudation, with which the texture is infiltrated, and from the profusion of growth to which that exudation ministers. Obviously then the symptom must vary according to the degree in which an inflamed texture holds this exudation within its substance. In cases of synovial and serous inflammation, the effusion which collects within the shut sac represents what in solid organs would be swelling from infiltration; and where mucous membranes are inflamed, the altered secretion which falls from their surface is, in the same sense, equivalent to swelling. Yet even in these cases (sometimes with the naked eye, sometimes with the microscope) we can recognise that the inflamed texture is not altogether free from true swelling, but presents an amplification of at least its epithelial layer:—the interference with respiration which belongs to the beginning of acute bronchitis, the filling-up of the kidney-tubules with modified cell-growth in scarlet-fever, and the diminished stream of urine during the severity of gonorrhœa, being in this respect illustrations of common inflammatory swelling. Not infrequently in such cases tumefaction extends to the subjacent areolar tissue;—acute ophthalmia may thus occasion the peculiar swelling which is called chemosis; and submucous inflammatory swelling is the cause of those ordinary urethral strictures which often remain from gonorrhœa. It needs hardly be said that, with rigid organs, there may be interior effusion which does not show itself outwardly; the crown of a tooth does not swell when its contained pulp is infiltrated, nor is a bone mechanically bulged out by the swelling of its medullary membrane. Likewise it is obvious that, in loose-textured organs, exterior enlargement will be preceded by a certain amount of solidification of the texture;—thus, the state of a lung hepatised by pneumonia is (like that, already mentioned, of the scarlatinal kidney) pathologically equivalent to a state of swelling.

That *pain* is a common symptom of inflammation scarcely needs be said or explained. Nerves would be of little use to the body, if they could remain unagitated during a process which essentially involves an unnatural destruction of living tissue. Whenever any bit of the body sloughs, ulcerates or softens, every included nerve-fibril must share in the common disorganisation; and it seems probable * that, even in less destructive inflammation, the involved nerve-fibrils undergo such an amount of structural change, as fully to account for pain being experienced by the patient. But different inflammations cause widely different amounts of pain; and there are cases, even of very considerable inflammation, where pain is almost absent. These differences of the symptom require some consideration.

Disorganisation of nerve-supplied tissue, and stretching or compression of nerve-fibrils, are the two great occasions of inflammatory pain. On both accounts, pain proportions itself rather to the intensity than to the extent of an inflammation; and the most agonising of all inflammations are those (sometimes of very small extent) where the focus of inflammation is so girt round by unyielding tissue—bone or fascia, that ever so little inflammatory swelling becomes a tight compression of nerve. As instances of this, it is enough to cite the extreme pain which attends inflammation of the tooth-pulp or of the tympanum, or generally the great pain which attends inflammation of dense tissues.

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* See Lent, op. cit.

Comparatively painless inflammations are chiefly the superficial desquamative inflammations of membranes:—in cholera, for instance, the epithelium of the intestine strips itself off almost without pain; and in some kinds of peritonitis, pleurisy and pericarditis, the serous membrane desquamates, amid a vast exudation from the liquor sanguinis, with almost no pain and but very slight tenderness. The chief governing condition of these apparent exceptions is, it seems, generally, that the inflammation, measured at any one spot, is not intense, and does not much affect the nerve-containing depths of the texture. Moreover, the cases of serous inflammation where there is no pain are eminently cases where the inflammation arises in conditions not primarily of a simply irritant kind—cases especially, where (as in puerperal fever) morbid poisons are operating on the part; and probably the magnitude of the local product, as compared with the local pain, expresses that the product is less due to mere intensity of the local process, than to something constitutionally specific which enables exudation to take place with a minimum of textural excitement.

As inflamed parts are not all painful in the same degree, neither are they all painful in the same sort. Indeed the quality of pain differs almost as much as the amount. In those phlegmonoid and tight-bound inflammations where pain is most intense, it especially tends to be pulsatile or throbbing; for every beat of the heart increases that local tension which is the immediate cause of suffering. A sense of extreme local compression—a feeling of being screwed in a vice, is often complained of under these circumstances. In surface-inflammations, the more diffused pain is apt to simulate the impression of fire, or, if less, that of nettles or needles; and the suffering part is said to prick, or tingle, or burn. Where ulceration is in progress, the patient's feelings almost represent the fact; for he describes his pain to be that of "something gnawing" at the part.

It is not only by being painful that an inflamed part gives evidence of disordered nerve-action. Over-sensitiveness to exterior impressions is other evidence to the same effect; and this—sometimes in the form of tenderness on contact or pressure, sometimes in forms special to the affected organ, always accompanies pain, if the pain be due to inflammation. The fact of its presence or absence is therefore of great importance, when we would interpret the meaning of any given pain. And further, since tenderness often exists in cases of inflammation where pain is unmarked or absent, it is a sign which, in difficulties of diagnosis, ought always specially to be looked for. Indeed there are many questions in surgical practice, where the principal business of the examiner is thoroughly to ascertain the existence and the limits of this one symptom; and the surgeon can hardly exercise too much care, when conducting this part of an examination, to exclude all sources of fallacy which depend either on himself or on the patient.

Where mucous membranes are inflamed, their increased sensibility often shows itself by producing increased reflex-motory phenomena. And the muscular actions which thus result become indirectly symptomatic of inflammation; for they testify that the nervous centres which regulate them have received from the mucous surface certain exaggerated representations of contact. Thus it is that common catarrh produces cough, that bronchitis and asthma become associated, that inflammation of the stomach is attended by vomiting, and that during the slight cystitis of gonorrhœa the patient's urine is often squirted into his breeches.

Where organs of special sense are inflamed, special sensations are experienced. The patient with deep-reaching inflammation of the eye seems to see sparks or flashes of light; the patient with post-faucial catarrh gets a sense of bitterness in his throat; the patient with inflammation of the internal ear has an impression of unreal sounds. Such signs, where they exist, are of course pathologically equivalent to pain. And as there are these special analogues of pain, so there are special analogues of tenderness; witness the intolerance of light which attends many ophthalmic inflammations, and which is as much a fact of over-sensitiveness as if the eye were painful on pressure.

It remains to be mentioned that pain, as a symptom of inflammation, is often referred to a larger extent of tissue than is actually inflamed, and sometimes to parts not directly continuous with the inflamed one. The pain of a whitlow, at first confined to the immediate vicinity of the nail, where alone the inflammation exists, may presently include the finger, then affect the whole hand, then the forearm, and finally give uneasiness to the whole extremity as high as the shoulder. The pain of ophthalmic tension is in great part referred to the brow. The pain of hip-disease is often chiefly, or even entirely, referred to the knee. Out of the pain of common toothache, semifacial, semicranial—even semicervical, pain may develop itself. Inflammation of the liver commonly produces pain in the right shoulder; the pain of renal inflammation is more or less referred to the bladder; and inflammations of the pelvic viscera cause pain to be felt in the thigh.

Heat:—It has long been matter of common observation that an inflamed exterior part is hotter than natural. And this increased heat, where it exists, is accepted for a sign of inflammation as much as either pain, redness or swelling. But hitherto the meaning of the symptom is not agreed upon by pathologists.

By some it is believed, chiefly on the strength of Hunter's experiments,* that an inflamed part is passive in the alleged change of temperature; that nothing more can take place in it than a raising of its temperature to that of the blood which supplies it; that, if an exterior part gets warmer when inflamed, this is simply because it is fuller of blood; and that interior parts (since their temperature naturally equals that of aortic blood) cannot be made warmer by inflammation.

By others it is believed, partly on theoretical grounds, and partly on the strength of some experiments* performed in 1835 by Messrs. Becquerel and Breschet, that an inflamed part is actively calorific; that it is, or tends to be, warmer than the blood which supplies it; and that this excess of heat is as much an effect of local action as the formation of pus, or the softening of spoilt tissue.

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* "A man had an operation for the radical cure of the hydrocele performed at St. George's Hospital. When I opened the tunica vaginalis I immediately introduced the ball of the thermometer into it, and close by the side of the testicle. The mercury rose exactly to 92°. The cavity was filled with lint, dipped in salve, that it might be taken out at will. The next day, when inflammation was come on, the dressings were taken out, and the ball of the thermometer introduced as before, when it arose to $98\frac{3}{4}^{\circ}$ exactly. Here was an increase of heat of $6\frac{3}{4}^{\circ}$; but even this was not equal to that of the blood, probably, at the source of the circulation in the same man. This experiment I have repeated more than once, and with nearly the same event. As the human subject cannot always furnish us with opportunities of ascertaining the fact, and it is often impossible to make experiments when proper cases occur, I was led to make such experiments on animals as appeared to me proper for determining the fact; but in none of them could I ever increase the inflammatory heat so as to make it equal to the natural heat of the blood at its source. I made an incision into the thorax of a dog; the wound was made about the centre of the right side, and the thermometer pushed down, so as to come in contact, or nearly so, with the diaphragm. The degree of heat was 101°; a large dossil of lint was put into the wound to prevent its healing by the first intention, and covered over by a sticking-plaster. The dog was affected with a shivering. The day following the lint was extracted, and the thermometer again introduced; the degree of heat appeared exactly the same, viz. 101°." Op. cit. vol. iii. pp. 338-9.

With reference to Hunter's view of the case, it may be fully conceded (putting inflammation out of the question) that any exterior part does get warmer in proportion as it is more copiously traversed by blood:—witness M. Bernard's curious discovery, that permanent and considerable increase of temperature takes place, without inflammation, in the integument of the head, whenever an experimental division of the cervical sympathetic has reduced the external carotid artery and its branches to a state of paralytic dilatation which occasions the textures supplied by them to be habitually overdosed with arterial blood. Accordingly, if Hunter's experiments were conclusive as to the *fact* of an inflamed part not being hotter than the blood which it receives, the explanations founded on those experiments would no doubt be satisfactory. On the other hand, if an inflamed part be (as Messrs. Becquerel and Breschet are supposed in some cases to have found) *considerably hotter than internal organs of the body* (which in effect would mean considerably hotter than the blood which it receives) then, we need hardly say, Hunter's explanation would be valueless.

Everything therefore turns on facts of comparative thermometry. And the solution is not easily to be obtained. For to learn by experiment—either generally whether textures are hotter than the blood which supplies them, or specially whether inflamed textures are paramount sources of heat, is a matter of infinite nicety. It is impossible to over-estimate the quantity of minute precaution which is necessary for properly performing such experiments. The passage of blood through a part incessantly tends to equalise its temperature with that of other organs; and unless the local production of heat were really considerable, all traces of difference would be thus swept away in successive waves of the circulation. Therefore not only is it the case, that the finest differences of temperature have to be accurately observed; but every alleged great excess of local temperature must at first be accepted with mistrust.

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* *Comptes Rendus de l'Acad. d. Sc.* tom. i., or *Ann. d. Sc. Nat.* The experimenters, using a thermo-electric apparatus with some arrangements devised for them by M. Sorel, attempted to take the temperature of certain skin-covered parts by needles thrust through the integument. The temperature of the *biceps flexor cubiti* was commonly thus taken as a standard of internal temperatures; and the temperature was also measured in the mouth. In a scrofulous girl, suffering from marked feverishness, the temperatures (centigrade) thus taken, were—in the mouth, 37·50; in the biceps, 37·25; in an inflamed scrofulous tumor at the lower part of the neck, 40; in a fungating tumor of the cellular membrane, also 40. In a woman, æt. thirty, having a similar disease;—mouth, 36·75; biceps, 37; tumor, 37·50; adjacent cellular membrane, 35. In a case of cancer of the breast;—mouth, biceps, tumor and certain fungations which were there, all 36·60. In a young man with scrofulous caries of tarsus;—mouth, 36·50; biceps, 37·50; wound (the needle going through the plantar fascia) 32. In a case of typhoid fever with bronchitis;—mouth, 39·65; biceps, 38·80. The reader will not fail to observe that these observations seem in various respects to contradict one another, and that, even on the assumption of their having been faultlessly made, no useful conclusion can be drawn from them.

It is not too much to affirm, that the opposed sets of experiments hitherto referred to are entirely inconclusive on the subject. In neither one set, nor the other, was there any attempt to deal with what would now be recognised as the difficulties of the inquiry. Hunter's observations were, in this one instance, evidently coarse and imperfect: the rival thermo-electric observations, though purporting to be more exact than his, are perhaps even less trustworthy;* and the alternative therefore still lies before us for decision,—"Is heat a symptom of inflammation only in external parts, and only as a passive result of their overfulness with blood? or is the inflamed part actively productive of heat?"

For settling this uncertainty, the writer believes that some thermo-electric observations which he, with the valuable aid of his colleague Dr. Edmund Montgomery, has recently made in the subject, may be deemed practically conclusive. And on the evidence of these experiments, he now ventures to say that an inflamed part is no mere passive recipient of heat, but is itself actively calorific. For, among the observed results, are these:—†

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* In the judgment of perhaps the first biophysicists of Europe, Helmholtz and Ludwig, the experiments of Becquerel and Breschet are of little value. Helmholtz (Müller's *Archiv*, 1848, p. 145) speaks of them as observations "gegen deren Richtigkeit viele Einwürfe erhoben werden können;" and Ludwig (*Physiologie*, edit. 1858, vol. i. p. 468) refers to the method of investigation as being "mit zu vielen Fehlern behaftet, als dass die durch sie gewonnenen Resultate werthvoll wären."

† The experiments referred to in the text may here be summarily described. First, as regards the apparatus employed (the entire merit of which belongs to Dr. Edmund Montgomery, who devised and arranged it for the writer) the essential facts are these:—A miniature thermo-electric battery was made by the angular contact of platinum and iron; each in a single delicate bar, which, where soldered to the other, was brought to such sharpness that the end of the metallic commissure could be thrust, like a pin, into any soft animal texture. Two such thermo-electric pins or batteries,

first, that the arterial blood supplied to an inflamed limb is found

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connected by copper wires with one another and with a sensitive nearly astatic galvanometer, were used as means for comparing the relative temperatures of media with which they respectively were brought into contact, and were found quite sufficient for the purpose; for when one of them was made ever so little warmer than the other, the fact was instantly indicated by a corresponding movement of the galvanometric needle. With this preface, the following tabular statement of experiments will sufficiently explain itself. A preliminary experiment, corresponding to those numbered 1, 7 and 9 in the table, was performed May 21, 1860, and showed (as in Nos. 1, 7 and 9) the higher temperature of blood returning from an inflamed part. The experiments here described were all performed May 24th. It will be observed that only *relative* temperature is measured; but also it is only with relative temperature that the argument at present is concerned; and it would have been no easy task, with existing thermometric appliances, to obtain the absolute temperatures for comparison, or even to translate the present comparisons into exact numerical expressions.

Subject of observation, and nature and date of injury which had caused inflammation.	Places of insertion of the thermo-electric pins.		Deflexion of needle indicating the side of higher temperature.	No. for reference
	Pin connected with the western half of the galvano-multiplier.	Pin connected with the eastern half of the galvano-multiplier.		
A dog with severe compound fracture of the right leg, inflicted about 72 hours previously; since when his general temperature had risen from 38·2 to 39·5 C.	in femoral vein of inflamed limb	in opposite femoral vein	Westward	I.
	in femoral vein of inflamed limb	in opposite femoral artery	Westward	II.
	in femoral artery of inflamed limb	in inflamed part	Eastward	III.
A second dog with severe compound fracture of the right leg, inflicted about 48 hours previously; since when his general temperature had risen from 38·1 to 39·3 C.	in femoral artery of inflamed limb	in femoral vein of inflamed limb	Eastward	IV.
	in femoral artery of inflamed limb	in inflamed part	Eastward	V.
	in femoral vein of inflamed limb	in inflamed part	Eastward	VI.
	in femoral vein of inflamed limb	in opposite femoral vein	Westward	VII.
	in abdominal aorta	in inflamed part	Eastward	VIII.
A third dog with severe compound fracture of left leg, inflicted about 19 hours previously; since when his general temperature had risen from 37·6 to 38·9 C.	in femoral vein of healthy (right) limb	in femoral vein of inflamed (left) limb	Eastward	IX.
	in femoral artery of healthy (right) limb	in femoral vein of inflamed (left) limb	Eastward	X.
	in inflamed part	in femoral artery of inflamed limb	Westward	XI.
For standard	untouched in atmosphere of room	between finger and thumb of experimenter	Eastward	XII.
	between finger and thumb of experimenter	untouched in atmosphere of room	Westward	

(Exp. 3, 5, 8, 11) less warm than the focus of inflammation itself;

secondly, that the venous blood returning from an inflamed limb, though found (Exp. 6) less warm than the focus of inflammation, is found (Exp. 2, 4, 10) warmer than the arterial blood supplied to the limb; and

thirdly, that the venous blood returning from an inflamed limb is found (Exp. 1, 7, 9) warmer than the corresponding current on the opposite side of the body.

Unquestionably, therefore, the inflammatory process involves a local production of heat.

Fully to interpret this fact is perhaps, in the present state of physics, not possible. Even an attempt thus to deal with it would here be an unnecessary digression; and the writer needs only advert to two points which are of most immediate interest. In the first place, let the fact of *local calorificity* be noted in connexion with the facts already stated of *local waste and local reproduction.* Let it be observed that this doubtless is an essential connexion,—that here (according to what seems the general and normal correlation of heat and life) an increased evolution of heat has accompanied the increased vital effort, the increased textural changes, of inflammation. And, in the next place, let it be noted, as a fact of which the importance will presently appear, that an inflaming part, in proportion to its heated venous outflow, necessarily raises the temperature of the common mass of circulating blood,—that thus the local disorder represents an influence which tends to diffusion throughout the body.

Reviewing then the four classical symptoms—pain, redness, heat and swelling, we find that in every examinable case of inflammation, they, or signs equivalent to them, may be locally discovered:—if not always pain, at least always *increased sensibility;* if not always redness, at least always *increased afflux of blood;* if not always swelling, at least always *increased textural productivity;* and finally, under all circumstances, *increased heat.*

Other local symptoms may be added to these. For, first, something *complicative* may come to them by mere accident of position. Where the walls of a visceral cavity are affected, the contained organs, originally free from disease, may be injuriously pressed upon or denuded. Where the neighbourhood of a canal is inflamed, the canal may be encroached upon by swelling. Where large blood-vessels are concerned, ulceration may be dangerous by hæmorrhage. And so forth.

And further, an inflamed part often gives rise to special symptoms of its own. For its function is interfered with by the disease; and signs of this *functional disturbance* are added to the common symptoms of inflammation. Thus, if the kidneys be inflamed, the urine will be altered in quality, will more or less tend to represent a mere filtration from the blood, or perhaps will be entirely suppressed; and secondarily there will arise the consequences of that general blood-poisoning which ensues whenever urine is imperfectly discharged from the system. Thus again, if the lungs be extensively inflamed, due aeration of the blood becomes impossible; and, while the patient is tending to die by suffocation, chemical analysis may show that waste carbon which his lungs cannot oxidise and discharge is passing by other channels from the body.* In these, and in almost all cases of inflammation, the nature of the functional disturbance is, that the function is more or less suppressed. To some extent this comes mechanically, and is, so to speak, an accidental complication of inflammatory swelling in the part. But greatly also, at least in most cases, it has to do with another influence, and implies for function what disorganisation implies for structure—death. And just as, amid the structural disorganisation of inflamed parts, we recognise traces of mere hypertrophy wherewith the process (if gradual) commenced; similarly, were our knowledge of function more complete, we should probably find that, so far as functional disturbance in inflammation is not of mechanical origin, thus far it also begins with mere over-performance of natural acts, and thus far the eventual suppression of function denotes *exhaustion subsequent to excitement.* It is only with respect to the nervous system that observation can here be appealed to; but the relations of cramp to paralysis, of delirium to coma, and of madness to dementia, may be quoted as of the kind in question.

It remains to be stated that inflammation has, besides its local symptoms, another essential characteristic. In proportion as any considerable part of the body becomes acutely inflamed, the patient's blood (if not affected by perturbing causes) invariably rises in temperature, and herewith the patient complains of what is commonly called *feverishness.* Taking, for instance, a case of severe compound fracture, without much hæmorrhage, in a person otherwise sound and strong, we find that, before twenty-four hours have elapsed from the time of injury, his general system begins to be thus affected:—He feels hot, or alternately very hot and chilly. His skin and lips and mouth are dry. He passes urine in less quantity, but of higher colour, than usual. His pulse is quickened. A sense of general disorder gains upon him. He becomes restless and intolerant of disturbance. Signs of drought increase with him. His urine becomes scantier and more coloured. His skin feels hotter to the surgeon's hand, and his pulse, whether full or hard, is quicker and stronger than before. He craves more and more for water. His face has a flushed anxious look. He is thoroughly uncomfortable; for the most part feeling distressingly hot, but at irregular intervals feeling touches of chilliness—sometimes even of such cold that he shivers with it. His sleep is troubled and unrefreshing; or, as night comes, he gets delirious. His tongue, besides being dry, is furred. If his bowels act (which commonly they are inapt to do without laxatives) the excretions are morbidly offensive. Gradually these symptoms give way:—in proportion as the injured limb ceases to be tense and passes into suppuration, the skin and mouth become moist again; the excretions lose their concentrated character; the hard pulse softens, and the heart's action becomes quiet; the nervous system is no longer restless; the look of trouble passes from the countenance; and the patient can again take solid food.

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* See Beale, op. cit. p. 354; where an instance is given of melituria thus dependent on pneumonia.

The constitutional affection which thus runs its course in sympathy with the local inflammation is commonly known by the name of "inflammatory fever." The description just given of its symptoms purports only to represent the chief facts of a typical and uncomplicated case. But practically the affection shows numberless grades and differences and complications.

First there are wide differences of degree and duration:—for, in proportion as the local process is less acute and less extensive, there is less attendant febrility; and in proportion as the local process has to invade fewer successive strata of texture, the fever is of shorter course. On the one hand, it may be so slight as readily to escape notice, and may end within a few hours of its commencement; on the other hand, it may last in full force during many successive days, and may be so severe as to shake the patient's life to its foundations.

And besides these differences, there are varieties of result, sometimes from complicative local conditions, sometimes from peculiar susceptibilities of the patient.

If the wound become the seat of some large textural disorganisation, with consequent soakage of putrefying material, signs of blood-pollution may be expected to mix with or supersede those of common inflammatory fever ;—the patient's general state will then incline to be one of depression and apathy ; his tongue will be more than commonly foul, and fœtid diarrhœa will probably exist. Or if perchance during the local process it happen (as is especially apt to be the case where cancellous bone-structure is affected, and generally at a time when common febrile excitement has passed its maximum) that pus passes up a vein into the general stream of blood, the patient's improvement is abruptly cut short by the severe recurrent rigors and sweatings of pyæmia, accompanied by local signs of secondary suppuration in parts to which the pus is conveyed.

Further, the quality of the pulse during inflammation, and generally that look of vehemence in the febrile process which depends upon the circulatory system taking an active part in the production of symptoms, will be almost unlimitedly influenced by the more or less vigour of the patient. With weakened nerve-power, with feeble heart-structure, there can be no strong, hard pulse; nor can the pulse be otherwise than soft or small, when the blood-vessels are half-emptied of their contents. Old age, and every kind of depressing, debilitating or exhausting influence, must therefore tend to prevent certain symptoms of fever from developing themselves ; and the surgeon, who wishes rightly to estimate the degree in which his patient's general system is sympathising with some existing inflammation, must guard himself against these sources of fallacy, by referring in all doubtful cases to what is the one sure measure of fever.

It has already been said that in proportion as any considerable part of the body becomes acutely inflamed, the patient's blood (if not affected by perturbing causes) invariably rises in temperature. This is the essential fact of inflammatory fever. It is to this fact, that the familiar language of feverishness bears witness ; the thirst, the scanty urine, the heat and the shivering, the troubled brain, the excited circulation. As the blood gets hotter and hotter, more and more do these symptoms become developed. As the blood subsequently gets cooler, so, more and more, do they decline.*

It is necessary to remark that what is here said specially of the symptoms of inflammatory fever, is true generally of the febrile state. Whether we are dealing with the effects of mechanical injury, or with a case of smallpox or pneumonia, the symptoms which in common medical language are called *feverish*, are essentially the signs of heated blood. This in effect is no new doctrine; for even Galen, seventeen centuries ago, when maintaining that fever was but a preternatural bodily heat (παρα φυσιν θερμασια) disclaimed originality of opinion, and declared that popular instinct, on this point, concurred with the teaching of all competent physicians. But it is only of late—only with aid of exact thermometric observations, that the facts have been scientifically established; and hitherto the subject has been much less studied in surgical practice than in connexion with infected fevers and visceral inflammations. Especially

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* The following observations of temperature in common inflammatory fever were made for the writer by Dr. Montgomery during the compilation of the present paper, January 1860. The cases were all in the wards of St. Thomas's Hospital;—the first three under the writer's care, the fourth

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under that of his colleague, Mr. Clark. The subject is further illustrated by the observations of general temperature made in connexion with the experiments recorded at page 43.

Day of observation.	*Man, aged* 29. Amputation above knee for osteosarcoma of the tibia.			*Man, aged* 41. Injection of tincture of iodine into the knee-joint for chronic hydrarthrosis.			*Man, aged* 36. Small tumor removed from the upper surface of the foot, 44 hours before the first temperature was taken.			*Boy, aged* 16. Syme's operation, 46 hours before the first temperature was taken		
	morn. 10—11	aftern 3—4	even. 8—9	morn. 9½—10½	aftern. 3—4	even. 8—9	morn. 10—11	aftern 4—5	even. 8—9	morn. 9—9½	noon 11½—12	aftern 4—5
I		36 15	36·50		36·55[1]	36 50	38·20	38·30	38·90		36 60	37·90
II	36·40	36·50	36·60	36·30	36·50	36·70	38·30[2]	38·30	38 20	37·30	37·80	38·40
III	36·40	Operation at 2·30	36·75	35·90	Operation at 3·20	37·00[2]	37·65[3]	38·10	38·10	37·20	37·15	39·40
IV	38·30	38 30	38·20	37·70[3]	37·70	38·30	37·10	37·10	37 20		36·80	38·80
V	37·90	38·40	38·30	37·60	37·45[4]	38 20	36·70	36·70	37·10	36·40	39·40[2]	38·00
VI	39·20	37·30	38·05	36·70[5]	36·90	37·20	36·60	36 70			36·60	37·40
VII	37·70	39·10	38·20	36·35[6]	36·50	36·20					36·30	37·30
VIII	37·50	38 00	37·80	36 30						36·20		37·00
IX	36·85	37·30	37·7							36 25		36·45
X	36·80	37·20								36·25		36·60
	[1] At 7 morn. slight shivering.			[1] Patient keeping his bed. [2] Pain began after 5 afternoon. [3] Knee swollen and painful. [4] Pain also in opposite knee, and in both legs from knees downwards. [5] Diminution of pain and swelling has begun [6] Scarcely any more pain.			[1] Inflammation of the tissue surrounding the wound; foul tongue:—sickness:—headache. [2] Inflammation spreading over the upper surface of the foot [3] Sloughing of flap of integument.			[1] At 1·30 p.m. patient had shivering. [2] At 11 morn. some shivering.		

the connexion of those thermometric facts with others of a chemical kind—a connexion tending to show that febrile heat is always associated with an increased devitalisation and waste of organic material within the body, is even yet but in progress of being demonstrated, and only admits of being stated in very unprecise terms. So far, however, as the subject is yet learnt, the following propositions seem certain :

1) that increased temperature of the blood is (as above stated) an invariable fact in the febrile state, and according to its degree, measures the intensity of fever ;

2) that this statement applies, not only to the facts of continued, uniform febrility, but equally to those of remittent and intermittent febrility, including ague and hectic ;

3) that the feelings of chilliness—even the rigors, which are a conspicuous symptom in many febrile disorders, furnish no exception to the general statement ; that, on the contrary, febrile chilliness probably denotes a more rapid heating of the blood ; and that febrile rigor, as it occurs in ague and pyæmia, is distinctively the sign of sudden rises of temperature ;

4) that febrile excesses of bodily temperature range perhaps to F. 10° above the normal heat of the blood ; that the "crisis" of a febrile state consists in a rapid and generally continuous reduction,—the "lysis" in a slow and generally discontinuous reduction, of this abnormal temperature ;

5) that excessive heat of the blood suffices to explain the apparent drought of the body ; for the contact of the hotter blood, acting as an universal textural stimulant, and rendering every particle of living texture throughout the body more than commonly absorbent and appropriative of blastema, necessitates (if the blood's ordinary constitution is to be maintained) that a greatly increased supply of water shall be furnished from without, and implies that, till the satiation of this requirement, the excretions shall be comparatively waterless ;—beyond which, it is to be counted that hotter blood inevitably steams away much more vapour by the lung ;—and further it may possibly be the case, as Dr. Parkes very ingeniously suggests,* that some intermediate waste-products of the febrile body are (like gelatine) extraordinarily attractive of water ;

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* "It is now well known that during endosmosis different organic substances absorb or take very different quantities of water through membranes. For example, the endosmotic equivalent of sugar is a large amount of water, and, in consequence of this physical law, sugar attracts water

6) that excessive heat of the blood suffices to explain a stimulated state of nervous centres and of organs dependent on them; for (besides what is known of the action of heat on living textures generally) the experiments of Chossat have shown, with special reference to the nervous system, that, when its functions are in the very act of dying by starvation, a mere augmentation of temperature will revive their activity, and gradually bring the subject of experiment into a state from which recovery by nourishment is possible ;*

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largely from the blood, and carries it from the system. Hence the unquenchable thirst of diabetes; for every structure is robbed of its water by the powerful attraction of the diabetic sugar. Is it possible that in fever some substance is produced which has as powerful an attraction for water as sugar, and the action of which may cause the universal thirst? A fact mentioned to me by Mr. Graham will put my meaning in a clearer light. Mr. Graham has discovered that gelatine has an extraordinary attraction for water, so that it will even take it from alcohol, and render alcohol almost, if not quite anhydrous. This property, manifested at all temperatures, is particularly marked at the temperature of 98° to 100° F. Albumen, on the other hand, has little attraction for water, and yields it up at once to alcohol. Now supposing that, in the rapid metamorphosis of albuminous substances in fever, gelatinous compounds, or something approaching to them, were formed,—and this is by no means unlikely,—then, as a consequence of a physical law, the gelatine would at once take water from the albuminous tissues, and would necessarily give rise to intense thirst. Then, unlike sugar, the gelatinous substance would not be discharged, but must be converted into urea, and uric acid, as ordinary gelatine is when it is taken as food. I mention this hypothesis merely as an example of how water might be retained in the febrile body. At present, of course we do not know whether any such compound is or is not formed, for the transition-steps, and they may be numerous, between organised albumen and urea, are not yet known." *Gulstonian Lectures on Pyrexia*, in *Med. Times and Gazette*, vol. x. p. 333. These Lectures claim a very respectful mention; not only as embodying an admirable statement and criticism of the modern doctrines of fever; but equally as recording many important observations, made by Dr. Parkes himself, with regard to the acts of elimination in fever, and the relation of these acts to the abnormal heat of the blood.

* Monsieur Chossat's 29th experiment (though it did not, like many of the others, go on to the animal's complete restoration) may be quoted as illustrating this argument. "Une tourterelle, dont le poids initial était $= 142^{g}\cdot 52$, ayant été soumise à une alimentation insuffisante, vers la fin du 6^{ieme} jour de cette alimentation se trouva arrivée à l'état de mort imminente, et son poids était réduit à $96^{g}\cdot 66$.

Dans l'état en question, la station depuis deux heures de temps était devenue impossible: le corps était étendue, la tête pendante; les yeux étaient ouverts, fixes, sans clignotement, et le froissement des orteils n'accusait plus qu'un faible reste de sensibilité aux extrémités postérieures.

7) that excessive heat of the blood suffices to explain the excitement of the heart's action; partly as the result of a more stimulative impression on the endocardium, partly as the result of a more stimulative supply to the cardiac ganglia.

Taking it then for granted that the leading symptoms of fever are accounted for—some of them entirely, others at least in great part, by the fact of the blood's increased temperature;—whence, we may now ask, comes this greater heat of the blood? In the present state of physiological opinion as to the ordinary sources of animal heat, the speculation is instantaneous, that the greater heat of fever must correspond to some greater transformation of organic material. Many excellent observers have set themselves to inquire how far this conjecture is right; and the results of inquiry, so far as they have gone, are to the following effect;—that, either

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La respiration, depuis quelques minutes, n'était plus appréciable; le corps froid; la chaleur animale = 23°·0.

La perte de poids intégrale proportionnelle = 0·350. C'est dans cette état, que j'appelle de *mort imminente*, parce qu'au bout de peu de minutes il devait se terminer par la mort, que j'ai placé l'animal dans l'étuve, et que j'ai commencé le réchauffement. Appelons 0^h, $0'$ le moment du début du réchauffement, et voyons ce qui est arrivé pendant la durée de celui-ci.

Temps du réchauffement.	
0^h $0'$	Mort imminente; début du réchauffement.
0 2	La respiration est devenue très-marquée.
0 6	La respiration est bonne; l'animal est plus animé: il remue la tête.
0 7	Les yeux sont redevenues sensibles, et le clignotement est rétabli.
0 10	Respiration naturelle; la vie revient de plus en plus.
0 31	L'animal est bien vivace; il agite ses ailes comme pour se sauver.
0 34	La station sur les pattes est redevenue possible; mais elle est encore chancelante, et l'animal ne se soutient qu'en agitant les ailes; tête encore vacillante.
0 43	L'animal parait bien remis. Etant obligé de le quitter, je l'enveloppe d'un tissu qui l'empêche de s'envoler de dessus l'étuve pendant mon absence.
2 7	A mon retour, je trouve l'animal mort sur l'étuve, la tête renversée en arrière, dans un état d'opisthotonos. La chaleur dans le cloaque = 48°·7; le poids du corps = $90^{g}\cdot58$, et la perte pendant le réchauffement = $2^{g}\cdot08$.

L'animal n'ayant pas pu quitter l'étuve, comme il l'aurait fait, s'il n'y avait pas été emprisonné, il est évident que sa chaleur s'y était élevée progressivement à cinq ou six degrés au dessus de l'état normal, ce qui était plus que suffisant, comme on sait, pour amener la mort par la chaleur.

continuously during the intensity of feverishness, or else more abruptly and as it were decumulatively when feverishness begins to subside, there can commonly be traced in the febrile excretions an excess, more or less considerable, of those nitrogenous, sulphurised and phosphorised products which emanate from textural and humoral waste; that this increased elimination is observed even when ingestion has been reduced to a minimum; and that febrile excretions do therefore, as a rule, undoubtedly attest an increased devitalisation of bodily material. It does not hence necessarily follow that febrile heat is the effect of this increased material change. Alternatives are conceivable:—for the relations of heat and chemical activity to one another are relations of mutual causativeness or mutual convertibility: increased heat may cause an increase of chemical action, or increased chemical action may cause an increase of heat, or both heat and chemical action may together and simultaneously be increased under the influence of some third condition. And so far as our present subject is concerned, we are not logically justified in saying that febrile heat results from the increased chemical action which exists with it, unless we can at least show that non-calorific causes of chemical change were those which first operated on the patient's body. To elucidate this question, intimately connected as it is with what is most obscure in the correlation of physical forces, lies beyond the scope of the present article and, still more widely, beyond the writer's capacity and knowledge. Whether in reference to local inflammation or to general febrility, he can only venture to speak of the increased heat and the increased material change as two phenomena concurrent with each other. And instead of pretending to discuss what may be their mutual relations, he will rather take them as essentially conjoint. Viewing them thus together as one complex fact of dynamical excitement (complex in any inflamed texture, and complex in any fevered blood) and confining himself now again to the case of surgical inflammatory fever, he will only attempt to show how it is that this dynamical excitement diffuses itself in the body,—how it is, that, from being local, it becomes general,—how it is that feverishness superadds itself to inflammation.

Almost without hesitation we may assume that the process spreads by common material contagion; that the returning fluids of the inflamed part—its venous blood and its lymph, are the agents of constitutional infection. For if a part be developing preternatural heat and undergoing preternatural change, its venous and lymphatic out-flow must of necessity represent those excesses of heat and change; and this out-flow with all its belongings, material and dynamical, shedding itself without interruption into the blood, must straightway be diffused throughout the body. Not inactively, we may presume;—for the blood, receiving such increments of heat as the inflamed part thus contributes to its temperature, and receiving also that unwonted afflux of chemically-changing material which comes from the disorganising textures, is doubtless itself stimulated to greater activity of change. And as it circulates throughout the body, so, to every texture which it supplies, there is brought more than common incentive to change; till, in proportion as the fever is great, every texture, according to its chemical mobility, gets to participate in the excitement, reflects* as it were in a lesser scale the disorder of the inflamed part, and contributes a share to that over-production of waste-products and of heat which is characteristic of inflammatory fever.

It were greatly to be wished that something definite could be said about the microscopical and chemical character of the blood during inflammatory fever. But observations in this field are among the most difficult in pathology; and probably many years must yet elapse before the subject can be adequately discussed.

It has been said by competent observers, that during inflammation there is a notable increase in the proportion of colourless corpuscles in the blood;—an increase, which, if it existed, would probably denote that the corpuscles are more abundantly contributed by the lymphatics of the inflamed part, and would to this extent accord with the familiar fact, that lymph-glands are apt to inflame in sympathy with the parts from which their lymph is derived. But our means for measuring the proportion of white to red corpuscles are hitherto so imperfect that different miscroscopical examinations of the same blood will give the most contradictory results; and the reports hitherto made on the subject in its relation to inflammatory fever are too imperfect and too discordant for general conclusions to be drawn from them.

There is another change in the blood which may with more confidence be described as at least very frequently an accompaniment of inflammation;—viz. that the blood yields more than the normal amount of fibrin, and coagulates with what is called a

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* The frequency with which, during accidental febrility, some predisposed texture will break out into the gouty or rheumatic inflammation special to itself, is a beautiful illustration of what is here advanced.

"buffy coat" on its surface. Perhaps no point is better established in the pathology of the blood than a connexion between its yield of fibrin and the presence of acute inflammation:—in rheumatic fever, in pneumonia, in bronchitis, in pleurisy, in peritonitis, in quinsy, in erysipelas, the blood's normal yield of fibrin has been found doubled, tripled, quadrupled, quintupled. And under like circumstances the buffy coat has been so habitually observed, that, in days when acute inflammation was much treated by venesection, the contents of the bleeding-basin were an ordinary element in diagnosis, and a buffy coat would be pointed to in justification of the blood-letting which had been performed.

Little is known as to the ultimate meaning of these facts. The buffy coat is an upper layer of clot left colourless by the absence of red corpuscles; and its immediate meaning is, that, through some peculiarity of the blood, the corpuscles have found time, before the beginning of coagulation, to subside in the liquor sanguinis from the top towards the bottom of the basin. Where blood shows the buffy coat, often, from the same cause, its clot has the shape of a truncated cone; the upper or buffy part being firmly contracted and having inverted edges, while the lower strata (where contraction is impeded by the volume of intervening corpuscles) become successively broader and looser-textured. Appearances, substantially the same, are of daily presentation in the structure of those clots which form slowly after death in the cavities of the heart and large blood-vessels, and which, because of their slow formation, are destitute of red corpuscles to a more or less considerable depth from their uppermost surface. And in healthy blood, withdrawn from the body, a buffy coat can to some extent be produced by various influences which, retarding coagulation, give more than normal time for the corpuscles thus to settle down. But slowness of coagulation is not, it seems, the only effective influence in the production of a buffy coat. The appearance may be absent even though coagulation have been slow, and it may be present where coagulation has been of normal rapidity. So at least it would seem from the observations of Dr. Stokes:*—"He noted the appearance of the blood in twenty-seven cases. In fifteen of these the buffy coat presented itself; in twelve it did not. Now in three of these twelve, the coagulation of the blood did not begin till from twenty to forty minutes after it was drawn; and in four others there was no coagulation for eight minutes. So that there was plenty of time for the red particles to have left the fibrin and subsided, but they did not do so. On the other hand, in twelve out of the fifteen cases in which the blood was buffed, the coagulation took place in five minutes; and in the remaining three it was delayed only fourteen minutes." It is evident that results equivalent to those of slow coagulation might be produced in other ways. If from any cause the corpuscles had acquired a special aptitude to subside (such, for instance, as greater weight would give them) the top of a clot would be left colourless, even though coagulation were not delayed; and some observers allege that, in blood drawn during inflammation, the corpuscles show a remarkable disposition to cohere in masses, which, they think, would be apter than separate corpuscles to sink in the containing fluid.

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* Quoted by Dr. Watson, *Lect.* vol. i. p. 155, edit. 1859.

Probably all that is peculiar in the coagulation of blood drawn during inflammation is essentially connected with that altered state of the fluid which occasions its greater yield of fibrin. And the nature of this state is hitherto quite unknown. Whether there be in the blood such an ingredient as fluid fibrin, chemically distinct from the dissolved albumen; whether the fibrin which we can whip from fluid blood be anything more than some of the albumen coagulating at a common temperature, just as the rest of the albumen would coagulate at 160°; whether the greater *fibriniferousness* of the blood during inflammation, instead of meaning (as has generally been believed) the increase of a specific ingredient, may not rather mean a general qualitative change in the albumen, rendering it abnormally prone to furnish the coagula which are called fibrinous,—these are questions which great chemists are still endeavouring to solve,* and which, while unanswered, imply darkness in many important parts of pathology.

Nor (whether fibrin be regarded as an ingredient or as a product of the blood) are physiologists altogether agreed as to its meaning in health, or pathologists as to its meaning in inflammation. There are some who believe that the blood is excellent in proportion as it is fibriniferous; that the quantity of fibrin which can be whipped from it represents the degree in which it is available for textural nourishment; that solidifying fibrin is, so to speak, almost incipient tissue; that the blood drawn in inflammation gives, in its fibrinous crust, the sign of being specially adapted to the purpose of additional growth. Others believe (and the writer is most unreservedly among them) that the blood yields more fibrin, not in proportion as it is ripe and perfect, but rather in proportion to quite opposite conditions; that an increased yield of fibrin portrays not perfection, but post-perfection, in the blood; that it corresponds not to the rise, but to the decline, of albuminous material; that its relations are not with repair, but with waste; that its significance is that of something intermediate between life and excretion. That the fibriniferousness of the blood is undiminished, probably even increased, by bleeding; that it is greatly developed during starvation, during violent fatigue, during diseases essentially anæmic; that its increase under these circumstances of exhaustion, weakness and inanition, is to the full as great as its increase during inflammation; these considerations (to which many others might be added) seem conclusive arguments against the view first stated. And when the same considerations are viewed in connexion with the general chemistry of inflammatory fever, it seems impossible to doubt that the alternative view must be right,—that the greater fibriniferousness of the blood in inflammation represents actions of devitalisation and decay in some albuminous material. Whether this changing material be the inflamed texture gradually dissolving itself into the blood, or be the albumen of the fevered blood itself undergoing accelerated waste, cannot, in the present state of knowledge, be even approximately stated.

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* See especially Brücke's paper on the cause of the coagulation of the blood; *Brit. For. Med.-Chir. Rev.* Jan. 1857, and Virchow's *Archiv*, vol. xii.

C. THE CAUSES OF INFLAMMATION, AND THEIR RESPECTIVE MODES OF ACTION.

As the chemist, referring to common combustion, would not describe its cause to consist in the mere igniting spark which determines its commencement, but would show that conflagration requires the fulfilment of many conditions, whereof only one is represented by that incident;—just so the pathologist, in dealing with the so-called causes of inflammation, recognises that no foreign agent operating on a part of the body would be capable of producing inflammation, unless other conditions were fulfilled by the part whereon it operates. Even as a certain constitution of matter is alone capable of combustion, even as the access of surrounding oxygen is necessary to support the process, and, except for the fulfilment of these concurrent conditions, the spark would be powerless to make fire;—just so it is with the production of inflammation. Strictly speaking, the cause of inflammation in any particular case is a complex of many conditions; the natural endowments of the part being, in this respect, as important as the agent which affects them; and surrounding circumstances contributing their full share to shape the particular result.

The powers which thus concur in producing any given inflammation are commonly distinguished as follows, viz.—

1) the *determining or exciting* cause, often spoken of solely as *the* cause of the inflammation,—being that relatively exterior influence which determines the commencement of an action for which the part by its natural endowments is prepared;

2) the *modifying and predisposing* conditions,—being all such circumstances and endowments of the part, as enable and prepare it to inflame;

3) the *proximate* cause,—being that which seems immediately efficient in producing the local changes, and which in fact is but the native power of the part, ministered to by surrounding influences, and excited by the determining cause of the inflammation.

The present section will be devoted to considering (in accordance with this distinction) first, the determining causes of inflammation; and secondly, the conditions which predispose to and modify inflammation. Where "cause" is written without any qualifying word, the reader will understand that "determining or exciting cause" is meant; and the expression "determining cause" will be preferred to the expression "exciting cause," with which it is synonymous, in order to avoid the ambiguity which would often result from the double meaning of the latter.

1. *Determining Causes of Inflammation.*

If the practical surgeon, from an exclusively clinical point of view, enumerates the causes which he has known to produce inflammation, they at first seem to be of almost infinite variety and multitude:—

> For hot, cold, moist and dry, four champions fierce,
> Strive here for mastery, and to battle bring
> Their embryon atoms; they around the flag
> Of each his faction, in their several clans,
> Light-armed or heavy, sharp, smooth, swift or slow,
> Swarm populous, unnumbered as the sands
> Of Barca's or Cyrene's torrid soil.

Classification, however, soon simplifies this chaos. For, on the one hand, the innumerable causes of inflammation may be generalised according to the sources whence they are derived;—generalised, for instance, into external and internal causes, with more or less subdivision of each of these chief groups. Or, more philosophically, the causes of inflammation may be classified according to the nature of the action by which they produce inflammation in the living body. And since the former mode of arrangement is convenient as an introduction to the latter, the causes of inflammation shall here be considered in that point of view. But, before closing the present section, some supplemental remarks will be necessary as to the results of the other kind of classification.

(a) *Determining Causes of Inflammation, generalised according to the sources whence they come.*

1. Parts of the body which have been cut, stabbed, bruised, torn, rubbed, broken, and dislocated; parts which have had foreign bodies, whether lifeless or parasitic, thrust into unnatural contact with them; parts in which, by heat or other caustic and pungent influences, the chemical constitution or chemical mobility of textures has been affected; these, in their several ways illustrate one great class of causes of inflammation—causes, namely, which may be generalised as *acts of mechanical and chemical violence* inflicted from without.

2. The influence which, as just mentioned, is exerted on living textures of the body when foreign matters (splinters or bullets, for instance) are intruded on them from without, is sometimes effectually imitated by the influence of peculiar *morbid products* of the body itself. Within the kidneys or bladder, for instance, a stone concreted from the urine produces just such effects as if it were a pebble from the sea-shore. Its action is that of a foreign body; and in our long catalogue of bodily diseases there are many cases where, with other anatomical relations, like results are produced. Biliary concretions in the liver and gall-bladder often produce inflammation, which sometimes involves the surrounding parts, and may even lead to the discharge of the irritant by ulceration of the abdominal wall. The salivary ducts, too, are subject to calculi, and to inflammation as the result of their presence. The lachrymal apparatus has the same liability. The joints moreover have their concretions, and the serous cavities have theirs; though in both these cases the polished surface of the formation renders its presence comparatively unfelt.

Akin to the above are cases, where *retained putrefiable excretions* become irritants to the cavities which contain them:—where, for instance (as often happens, sometimes unsuspectedly, in connexion with chronic paralysis) an imperfectly-relieved bladder has arrears of urine always decomposing in it, rendering the calls of micturition more frequent, provoking a large secretion of mucus which itself becomes an aggravation of the disorder, and at length, unless appropriate treatment be adopted, producing destructive results;—or again, where, in connexion with stricture of the rectum or some other constipative cause, the retained and decomposing knobs of excrement irritate the mucous membrane of the colon, exciting catarrhal secretion and increased efforts of discharge—a pseudo-diarrhœa, which, unless it be duly diagnosed, may be very erroneously treated.

Of immense importance in the present category are *concretions of blood* (usually extravasated blood) and of *tubercle.* Blood, when it is effused among living elements of the body, without exposure to the air, is often little of an irritant; but, to the extent of its influence, it acts as a foreign body, and, where in contact with irritable organs (as we often see with small apoplectic effusions at the roots of nerves) can thus make its presence sufficiently obvious. So again, the small fibriniform concretions in the lungs which constitute miliary tubercle, are as foreign bodies in their power of exciting textural irritation where they lie. But it is not in their concreted state that tubercle and effused blood produce their maximum of irritation: it is when decomposition begins either in stagnant blood or in masses of tubercle, that the material, as it softens, has new irritating properties superadded to those of mere extranëity, and becomes to the affected part one of the most disorganising of influences. The common cause of secondary hæmorrhage from tied arteries is an ulceration produced by this irritative transformation of clot: the inflammation of aneurismal sacs with large coagula begins in the same way: and the breaking-up of the lung in phthisis, as more and more tubercle softens in it, is a phenomenon of the same compound sort.

An influence very comparable to that of concretions and foreign bodies is the irritation which *parts suddenly deprived of life* produce in the parts next adjoining them. When, for instance, obstruction in the arteries of a limb is such that the extremity dies from anæmia, or when the hand or foot is killed by an extreme action of heat or cold, the dead part, relatively to the adjoining live parts, is as a foreign body; and its elements which can no longer themselves take part in any vital action, excite inflammation in those contiguous parts;—an inflammation, which, if at first it depends only on the contact of lifeless matter, becomes aggravated in proportion as that matter (undergoing common post-mortem changes) is rendered also a putrid irritant. A somewhat similar case is that where the crystalline lens, dislocated either by accident or in the utterly barbarous operation of depressing a cataract, becomes an irritant to the parts amid which it is thrust :—an irritant which (like the last named) is at first only mechanical, but is liable also to become chemical in proportion as changes occur in the displaced and dead material. A sequestrum of bone differs from soft sloughs in its comparative freedom from decomposing tissue ; but, though its influence in irritating contiguous parts is, to this extent, a simpler one, the resulting irritation is well marked :—in M. de Flourens's neat experiments, for instance, when a shaft of bone is made to die by the destruction of its medullary membrane, the dead cylinder of bone becomes a cause of inflammation to the untouched periosteum which invests it ; and when, contrariwise, a shaft is made to die by the destruction of its periosteum, it becomes a cause of inflammation to the untouched medullary membrane which lines it ; so that, while in the former case reparation proceeds from without, in the latter case it proceeds from within. And with the phenomena of necrosis in the human subject, we have daily opportunities, not only of confirming these results of experiment, but of noticing how essentially the effects of a sequestrum are the effects of a foreign irritant ;—how (for instance, with a dead bit of vertebra or of acetabulum) the surrounding parts are thrown into suppuration as though by a driven-in fragment of wood or metal ; how abscess follows abscess, and sinus succeeds sinus ; the drain and trouble indefinitely continuing, perhaps even to the destruction of life, unless the quasi-foreign body be removed.

Here then we have a second class of causes of inflammation ;— *retained concretions*, *excretions*, *sloughs and sequestra*, which themselves are results of disease, and which secondarily tend (sometimes by irritative products of their decomposition, but more commonly by their mere dead contact as foreign bodies) to provoke inflammation within the sphere of their influence.

3. Thirdly, inflammation may be caused through *an altered state of the local nerves.* It has long been known that injuries and diseases of the ophthalmic division of the fifth nerve lead to injection of the conjunctiva, to clouding and ulceration of the cornea, often to final destruction of the globe of the eye, and sometimes to ulceration of the neighbouring integument. Similarly it is known that experimental division or bruising of the pneumo-gastric nerves, at whatever part of their course, induces inflammation of the lungs. Also within the domain of the spinal nerves, disordered nutritive phenomena,

sometimes resulting in ulcer, have been seen apparently dependent on local failures of innervation.*

It is a curious and perhaps hitherto a not perfectly solved question, how these injuries of nerves act in producing inflammation.

A first evident fact is that, at least in the best-known cases, the injured nerve is a sensitive one; and ten years ago the most probable inference from this fact seemed to be, that inflammation arising in parts deprived of their sensibility was a reflex phenomenon; that the diseased or otherwise injured sensitive nerve conveyed to its ganglionic centre a false impression of the state of distant parts, and that this false impression, acting in a common excito-motory way, determined in the arteries of those distant parts the same changes of calibre, and consequently in the supplied textures the same changes of circulation, as if the misrepresented parts had really been injured. Now with reference to this explanation, it deserves notice that, if it were the true one, inflammation might be expected to concur with muscular paralysis even more frequently than with mere anæsthesia; since in that case we should anticipate greater (because direct, instead of reflex) effect on arterial contractility. But a stronger objection is this:—the explanation only pretends to account for the production of hyperæmia in the affected peripheral part; it would not account for the remaining phenomena of inflammation, except by assuming what, in the present state of knowledge, cannot generally be assumed—that hyperæmia, however induced, is in itself a sufficient cause for those phenomena.

Later inquiries, however, have pretended to establish, that injuries of sensitive nerves operate much less directly than has been supposed in occasioning the remote changes which are here referred to; that, in fact, there is no direct connexion between the injury of the sensitive nerve and the inflammation of the anæsthetised part; that the part inflames merely because it cannot, without sensibility, protect itself against innumerable irritants which are around it; and that if artificially it be protected against this kind of irritation, it will, though insensible, show no special tendency to inflame. Thus, for instance, as regards those very remarkable changes in the conjunctiva and cornea which ensue on certain injuries of the fifth nerve,—in some experiments, made three or four years ago at Utrecht by Dr. Snellen under the admirable guidance of Professor Donders, it appeared that if the eyelids of the insensible eye were stitched together, and the still sensitive ear of the animal were fastened as a shield over the part, no ocular inflammation would arise. So again with the pneumonia which has been observed as generally ensuing on injuries of the pneumo-gastric nerve;—Prof. Traube, so long ago as 1846-7, made it at least highly probable that this inflammation owes its origin to the circumstance, that, when the action of the vagus is withdrawn, irritative matters pass from the mouth into the air-tubes; for, not only did he detect the presence of such matters in the inflamed lung, but he found that when he had prevented this cause of disturbance (sometimes by cutting the œsophagus across, and sometimes by causing all respiration to go on through a tracheotomy-tube) pneumonia no longer arose within the period to which his experiments extended.* Another familiar illustration of the same kind is the catarrhal state of urinary bladder which arises in cases of paralysis;—the results of attentive catheterism seeming to show, that this inflammation does not depend on any direct action of the nerves on the nutritive changes of the mucous membrane, but on the mere mechanical and chemical irritation of urine which the paralysed bladder is not excited, or is not able, to expel.

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* "Several years ago I was consulted, at King's College Hospital, by a man who some months previously had torn his ulnar nerve at the inner condyle:—his two inner fingers had become swollen and livid with vascular injection. Two years ago, I had a female patient here [St. Thomas's Hospital] with disease in a large portion of the lumbar and sciatic plexus of nerves on one side, causing paralysis and anæsthesia of the limb; neuralgia was referred especially to the vicinity of the knee; and at this spot, when I first saw the patient, ulceration had occurred." J. S., *Lect.*, 1850.

It must be mentioned, however, that some still later experiments leave the question again unsettled.† For it is now alleged that galvanic irritation of the Casserian ganglion (effected in the rabbit by carrying into contact respectively with the sella turcica and the extremity of the petrous portion of the temporal bone two needles which are connected with the wires of a battery) develops an inflammation attended with *augmented sensibility* of the inflaming surfaces of conjunctiva and cornea; and the inference drawn from these results by Dr. Samuel of Königsberg, the author of the experiment, is, that the inflammation depends on an immediate influence of nerve on tissue. And even the above-quoted experiments of Dr.

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* *Beiträge zur experiment. Path. u. Phys.* 1846. *Entgegnung auf die Einwürfe*, etc. Roser's und Wunderlich's *Arch.* vii. 6, 1848.

† Samuel; *über den Einfluss der Nerven auf den Entzündungsprocess;* and *Entzündung durch Nervenreizung*, in *Königsberger Med. Jahrb.* 1858; abstracted by Virchow, *Archiv*, vol. xvi.

Donders and Snellen must be received with some qualification; for, however conclusively they establish that, after division of the trigeminus, the keratitis which commonly ensues is immediately due to the influence of exterior irritants, they do not set aside the statements previously advanced by Professor Gräfe;* — that great exposure and irritation of the cornea (such as is occasioned by cutting away the eyelids and the lachrymal glands) do not, when the trigeminus is uninjured, cause nearly so much inflammation as commonly ensues on section of the nerve; and that the phenomena which result from this unlimited exposure of the globe are also to some extent different in kind from those which follow section of the nerve.

At present, then, all that can be said on the influence of nerve-injuries in producing peripheral inflammation, is, apparently, this:—

1) that a part, in being deprived of sensibility, becomes specially incapable of protecting itself against mechanical and chemical irritants, some of which are almost certain to affect and inflame it;

2) that parts injured in respect of their innervation are likely in consequence to suffer some circulatory disorder with corresponding disturbance of natural temperature,—that perhaps they may thus be thrown into inflammation, or at least be specially predisposed to suffer from various common influences about them; and

3) that the possibility of other modes of action, though problematical, is not absolutely excluded.†

4. In a fourth great group of cases, inflammation results from certain *abnormal properties of the circulating blood.* And these cases are of two chief sorts:—for, first, the blood may be a cause of inflammation by reason of certain *deficiencies in its constitution;* and secondly, it may be a cause of inflammation by reason of its being *charged with some specific irritant.* But, with both sorts equally, it is to be observed that the blood is only mediately and passively concerned; so that for practical purposes, the cause of the mal-constitution of the blood is to be regarded as the cause of the inflammation.

First—as regards *defective constitution* of the fluid, there is abundant truth in the popular belief that "poor blood" causes

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[*] *Archiv für Ophthalmologie,* 1854.

[†] The writer may add (though without attaching much importance to the fact) that, in several experiments which have been performed for him in imitation of Dr. Samuel's, he has not yet seen the concurrence, which Dr. Samuel describes, of inflammation with hyperæsthesia.

many inflammations, and that the tissues of ill-nourished persons are, when injured, apt to inflame in more than common proportion to the hurt inflicted on them. Not only by the classical experiments of Magendie and Chossat, but by histories of national famine, and habitually by those instances of semi-starvation which not even a well-administered system of poor-laws can altogether prevent, we thoroughly know that living textures can be starved into inflammation.

Privation of nitrogenous food is a principal influence of the class now being considered. The corneal ulcers which in Magendie's* experiments were observed to arise in dogs fed exclusively on sugar, are important cases in point; and many of the external inflammations which occur so profusely among the poor are probably of similar origin. But absence of nitrogenous food is not the only dietetic deficiency which may lead to disorganisation of texture:—the well-known facts of sea-scurvy are evidence of analogous results arising where vegetable diet is withheld. And it is a point of much interest in reference to the present section of our subject, that scurvy is said to depend on privation of vegetable food, only in so far as this privation implies an absence of potash from the diet.† By cases like this one is reminded of the thoughts which Liebig has made common in agricultural science, and one is tempted to speculate whether perhaps there are other cases where the pathogeny of human inflammations, called idiopathic, might be explained with equal simplicity;—whether, for instance, some of those which are vaguely called "scrofulous"—the sore eyes, the sore ears, the sore noses, the whitlows, the congested and catarrhal mucous membranes, which so abound among ill-nourished children may perhaps depend, not generally on the deficient belly-full of food, but distinctively on the absence or insufficiency of one or two chemical elements.

It is a very interesting question to determine by what manner of action different kinds of privation are able to produce inflammatory excitement in the tissues which they thus affect. In the present state of knowledge, the only conceivable explanation is, that the excitement is secondary; that a certain quantity of textural death is the primary and direct result of the privation; and that this first-occurring effect leads to the other as its consequence.

Before quitting the subject of defective nutrition as a cause of inflammation, it is necessary to observe that textural starvation may be partial. Obliteration or narrowing of certain arteries—not enough to cause gangrene in mass, but enough almost entirely to anæmiate the affected part, may cause chronic inflammatory phenomena.* It seems probable, too, that the ulceration which is so frequently attendant on varicose veins of the lower extremity is of somewhat analogous origin; for in these cases the local circulation of blood is materially interfered with—not indeed as being stinted, but as being rendered stagnant; and tissues which cannot renew their supply of blood are physiologically circumstanced almost as if blood were withheld from them.

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* See his *Précis de Physiologie.*

† See Dr. Garrod in *Edinburgh Monthly Journal,* 1848.

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* The following notes of a case recently observed show a striking instance of anæmial ulceration. "E. P., æt. thirty-six, had been under observation for twenty months before his death, which took place on the 9th of February, in St. Thomas's Hospital. During this time he had been subject to a peculiar phagedænic process, under which he had lost most of the left side of his face. The disease began in the lower eyelid, and soon involved the globe of the eye; it then extended downwards, exposing the malar, maxillary, and nasal bones, which crumbled away in successive small sequestra; eventually, having opened largely into the nasal and buccal cavities, it attacked the base of the skull, and thus (after many months of extreme suffering) produced death by intra-cranial inflammation. The destruction did not advance uniformly; it was effected by successive little acts of sloughing, which alternated with feeble efforts of repair, and at every access left the patient with a larger and deeper excavation. There was no infiltration of surrounding textures; nor did the granulations, when they formed, ever tend in the smallest degree to exuberance. The meaning of the disease was not arrived at during life. Before the case came under Mr. Simon's care, an opinion had been expressed that it was cancerous; but the character of the sore was, Mr. Simon thought, conclusive against this view. The man having undoubtedly suffered primary syphilis, suspicions were entertained that the constitutional taint of the disease might be the cause of his local suffering; and various anti-syphilitic drugs were therefore carefully, but unsuccessfully tried. On post-mortem examination, it appeared certain that this intractable local disease had been a starvation-phenomenon resulting from obstruction of arteries. Of the three vessels arising from the arch of the aorta,—the left subclavian was completely obliterated by a firmly-adherent plug nearly an inch in length, the left carotid communicated with the aorta by an aperture only just capable of admitting an ordinary probe, and the origin of the innominata was reduced by encroaching deposit to one-third of its normal calibre. Beyond their points of origin, these arteries were of proper size and contained but little atheroma. The heart was healthy; but the coats of the thoracic aorta, along its whole length, were so much loaded with earthy deposit as to crackle under pressure. The brain was everywhere perhaps somewhat softer than natural, but with no difference in this respect between its two hemispheres. The lateral ventricles were distended with a turbid purulent fluid; their lining membrane was opaque, and their septum softened almost to diffluence. The base of the brain was coated with a layer of soft yellowish lymph, especially abundant in the middle line (about the circle of Willis and pons Varolii) and on the under surface of the middle lobe. The dura mater, corresponding to the latter portion of brain, was, for about two square inches, much discoloured, and had its arachnoid surface covered with lymph. The bone beneath it was necrosed to about the extent of a shilling." *Transact. Patholog. Soc. of London,* vol. x. p, 101.

Secondly (as above stated) inflammation is causable by *blood which contains abnormal irritating ingredients.* When, for instance, arsenic, improperly applied to an external sore, produces its characteristic effects within the abdomen, or when the application of a common blister produces strangury, the remote effect depends on the drug having been received into the circulation; and it is from the contact of a blood thus poisoned that the stomach or the kidney inflames. Similarly, if serous inflammations and vomiting and purging are incidental to those later stages of Bright's disease wherein the kidneys are almost incapable of secretion, this is because the blood, charged with the essentials of uneliminated urine, is an irritant to organs which it supplies.

A matter of much interest in the working of many common poisons through the blood is the evidence thus afforded of their different textural affinities; for, in whatever way arsenic or cantharides be introduced into the blood, there is always the same gastric or urinary irritation, and (up to a certain intensity of poisoning) always the same immunity of other organs. This electiveness of stimulant action is not confined to a few drugs having strongly-marked poisonous characters, but is a property so widely diffused as to determine the common classification of our *Materia Medica;* lying at the root of our purgatives, emetics, diuretics, emmenagogues, and so forth. And though our knowledge that certain drugs specially affect certain organs is of course not intentionally applied to the object of exciting inflammation in the organs which we can thus attack, it is very extensively applied to the object of stimulating them; and we frequently have opportunities of seeing this effect carried to a pitch where it at least verges on inflammation.

It may be convenient in passing to observe that not all drugs with definite textural affinities are *stimulants* to the organs on which they act. Almost of a certainty, there are some which exert a directly opposite action, and which therefore, if they ever cause inflammation, do so only (after the manner of cold and anæmia) by carrying the depression of textural vitality to the point of textural death. Again—a well-known and striking instance of textural affinity is that of madder for growing bone; but here there is no evidence to show that the ordinary process of ossification is in any way affected by the colouring matter which the texture appropriates; and there are similar cases, where, in the course of slow metallic poisoning, particular organs, both secreting and non-secreting, get specially imbued with the metal, yet do not during this process show any excitement of function.

As regards the governing principle of these curious elective affinities, there seems every reason to believe that they are subject to the ordinary laws of chemical combination; that in each case the drug is attracted by something chemically distinctive in the texture on which it acts; and that the resulting stimulation or depression of the texture's vital activity corresponds to a definite affection of the texture's chemical being, probably to increase or decrease in its previous rate of transformation and decay. As a physiological corollary of this argument, it may be expected—and practice confirms the expectation, that, where an organ is specially acted on by a drug, the drug shall be chemically demonstrable in the organ or in its secretion. And—subject only to such limitations as are imposed by the imperfections of our means of analysis, it may probably be said, that, wherever inflammation is caused by irritants acting through the blood, such irritants admit of being shown in the products of the inflammation.

In the study of agents which, when in the blood, exert specific powers of textural irritation, very particular notice is due to some which effect this result by acting after the manner of *ferments*. Possibly—even probably, there are drugs which act in this manner; but the familiar and proved instances, which here require special mention, are those of the so-called morbid poisons, alternately the products and the causes of various specific inflammations. The inhaled "something" which, after a fortnight's lingering in the body, covers the skin and mucous membranes with the pustules of smallpox, or develops the cutaneous blotches and respiratory irritation of measles, or sets the skin and kidneys desquamating and the tonsils sloughing with scarlatina, is as real an exciting cause of inflammation as any stab or bruise or burn. But between the two cases there is this difference;—with regard to the latter causes of inflammation, no bodily predisposition is necessary; but in all persons alike, on a certain quantity of stab or bruise or burn, inflammation assuredly results;—whereas, on the other hand, the morbid poisons are inoperative, as exciting causes of inflammation, except where there is a definite bodily predisposition; the contagium of smallpox or measles or scarlatina having no more power to influence the un-predisposed body than yeast has power to ferment alcohol, or to turn pure water into beer.

Between morbid poisons and the common poisons and drugs before spoken of, there is this further difference:—arsenic and scammony, for instance, so soon as the blood brings them into contact with the textures on which they operate, produce results proportionate to their quantity, and by doubling or quadrupling the dose we can double or quadruple the effect; whereas, with smallpox and scarlatina and measles, the characteristic inflammations are almost or quite without proportion to the original dose of ferment—whether some infinitesimal whiff of contagion from a passing patient, or the closest attendance in an atmosphere saturated with odours of the disease. The intensity of effect is essentially dependent on the amount of bodily predisposition which the dose of contagion encounters. And it is a further expression of this dependence to say, that the morbid poisons require incubation within the body; not overtly acting at once, when absorbed, as though they were the direct producers of inflammation; but manifesting their influence after days or weeks of latency, during which the bodily predisposition has been gradually fructified by their power. Evidently, then, what has to be said of these morbid poisons may best be said when the predisposing causes of inflammation are generally under review.

Here, too, it is requisite to mention, as a fact in close pathological connexion with those just referred to, that there are certain well-marked inflammations wherein, commonly speaking, textural predisposition is the one notorious fact, and exciting causes altogether elude discovery. Such, for instance, is the common paroxysm of gout; seldom associated with any local action of an ordinary exciting cause of inflammation, but, when thus associated, always showing distinctive phenomena which imply a previously exceptional state of tissue. These cases, like the last, may be more conveniently studied in connexion with the predisposing, than with the exciting, causes of inflammation.

5. It remains to be mentioned that inflammation may be excited by *contagion*.

Every body knows, for instance, that if two almost invisible scratches be made in the skin—one with a clean lancet, the other with a lancet on which previously there has been collected a minute quantity of secretion from a vaccine vesicle, or from a primary syphilitic sore, the one scratch will have no appreciable result, while the other (except under circumstances which need not now be referred to) will assuredly develop a peculiar train of inflammatory phenomena, due to the inoculation which has been practised.

Or, if a little gonorrhœal pus finds its way into the orifice of a healthy urethra, or on to the surface of a healthy conjunctiva, there straightway begins, in the membrane thus acted on, an inflammatory process which often is of great severity.

It has been too much the practice to regard these as exceptional facts in the history of inflammation, and to deem them sufficiently accounted for when cowpox, chancre and clap are designated "specific" diseases. Waving for the moment any discussion of what constitutes the undoubted "specificity" of the first-named two inflammations, it may on good grounds be asked with regard to gonorrhœa, whether it be anything more than a common inflammation of the affected membrane ;—an inflammation, which perhaps first originated, and may with infinite frequency re-originate, from local accidents of dirt and lust; and which, having thus originated, shows a more communicable character than some other catarrhal inflammations—than common cold in the head, for instance, only because genitals come into inoculative contact more frequently than eyes and noses. In the writer's opinion there is ample reason to question the popular impression, that only "specific" inflammations are communicable; much reason for suspecting it, on the contrary, to be a generic and essential property of inflammation, that its actions (or some of them) are always in their kind to some extent contagious.

Inflammations of the conjunctiva are, in this point of view, especially deserving of study. It has been extensively imputed to them that they are communicable; and although Dr. Mackenzie reserves the title of "contagious ophthalmia" for that severest variety, which has been popularly known as Egyptian, he, in strong terms, claims the property of contagiousness for the common catarrhal ophthalmia of this country. Dr. Guillié proved the contagiousness of the infantile ophthalmia on which his experiments were made; Sir Patrick Macgregor's large experience furnished him with many instances where apparently common ophthalmia displayed contagious properties; and the testimony of these two writers might properly be here quoted, were it not that the following facts seem briefly to exhaust all sources of doubt on the subject. Among ophthalmic surgeons, especially in Germany, there has been a practice of treating that vasculo-nebulous state of cornea, which is called *pannus*, by artificially superinducing an attack of acute ophthalmia; and the agency which has been employed for this purpose has been the insertion of some contagious secretion. It is obvious that this method of treatment gives extensive opportunities for testing the communicability of various inflammations; and many such experiments are referred to in Dr. Piringer's work on ophthalmia.* This author states that in his own experience, including a few cases in which his assistant had acted for him, he had 87 times (*i. e.* operating on 87 eyes of 52 different patients) succeeded in exciting conjunctival inflammation by the contact of an inflammatory product; that the material for the operation was taken—in 29 cases from eyes with infantine ophthalmia, in 11 cases from eyes with gonorrhœal ophthalmia, in 2 cases from the urethra of a boy aged three and a half years, in 40 cases from eyes with acute decidedly non-gonorrhœal ophthalmia, in 2 cases from the eye of a child with acute palpebral ophthalmia, in 3 cases from eyes with old-standing chronic ophthalmia. The evidence of such experiments becomes (as Dr. Piringer observes) overwhelming, when it is considered that, in performing them, the secretion was often carried, as we carry vaccine lymph, over a considerable distance from case to case; and that symptoms of ophthalmia not only always began within a few hours of the operation, but began only in that eye which had received the morbid material. And now (it may be asked) in what sense, not involving a *petitio principii*, can the word "specific" be applied to those various conjunctival inflammations which showed themselves communicable? and, if they were not "specific" but common inflammations, where is the reason for believing that the communicability of gonorrhœa constitutes it a "specific" disease?

Of great importance to the present argument are the facts of simple pyæmia,—*i. e.* the phenomena which result from the passage of mere clean pus into the circulation, as distinguished from those more complex and more rapidly fatal results which arise when the pus is admixed with softening fibrin and other putrescent matters. If clean pus be so introduced into a vein that it passes onward with the stream of blood, it gets mechanically arrested in the next capillaries to which the circulation carries it, and there leads to the formation of abscess; and as further intravascular diffusion of pus proceeds from this source, other abscesses arise wherever that pus is carried. Thus, for example, when pus accidentally passes up the vein of an extremity, its corpuscles get more or less completely caught in the capillaries of the lungs, and produce in those organs the earliest effects of their introduction; while such of them as elude that first filter, together probably with younger forms of pus which the arrested corpuscles have occasioned to be developed in the lung, pass by the pulmonary veins into the aortic circulation, are diffused by many arteries to many parts of the body, and give rise to the multiple suppurations which are so characteristic of pyæmia. Similarly, when the infective entrance of pus is into some vein of the digestive system (as, for example, into a mesocolic or inferior mesenteric vein, in connexion with the ulcers of dysentery) the first stoppage of the inflammatory product is made by the capillaries of the liver, and hepatic abscess is the immediate result; the lung suffering only in proportion as pus passes onward to it from the liver, and other organs suffering only in proportion as the left ventricle transmits to them a purulent blood from the pulmonary circulation. Here then, primarily, secondarily and tertiarily, are facts of inflammatory contagion:—whithersoever the pus is carried, there unfailingly it produces suppuration; so unfailingly that, as has been said, "if, by way of experiment, you inject a little pus into a vein, you are able to foretell the result just as certainly as if you transferred a handful of frog's spawn from one ditch to another."

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* *Die Blennorrhœa am Menschenauge;* Grätz, 1841.

But there are other facts—facts almost obtrusively familiar in daily practice, which have hardly yet been appreciated in their bearing on the present subject. What is the meaning of the ordinary "sympathetic" diffusion of inflammatory excitement in the body? When, for instance, in order to make an issue, we burn (say, with moxa) a piece of skin the size of a sixpence, why do the surrounding textures to the size of half-a-crown, show that they have been disturbed? and why do the nearest lymph-glands become somewhat swollen and sensitive? Why, when inflammation is produced—say, in the skin and cellular membrane of a finger, by the impaction of a splinter of wood, does not this inflammation confine itself to the particles of texture which are in contact with the wood? why does it go on spreading, hour after hour, in wider and wider circles, dying away as vaguely in the distance as the undulations of ruffled water? and why, three feet off, do the lymph-glands in the axilla swell, and grow painful and tender, and not unfrequently suppurate?

Here are two striking facts of inflammatory contagion. On the one hand, as regards the spread of inflammation according to continuity of tissue, the fact can scarcely be stated in any other ætiological form than this;—that such particles of texture as are directly affected by causes of inflammation become capable of exciting inflammation in particles with which they have contact; and the fact, thus stated, embodies the whole doctrine contended for. On the other hand, the fact, that lymph-glands in connexion with an inflaming part are themselves always more or less thrown into excitement, is assuredly not less suggestive:—for, between the primarily inflamed finger and the secondarily inflaming gland in the axilla, there is but one conceivable course or vehicle of influence; and, since the only essential ground of sympathy between the two parts consists in the fact that the one of them naturally receives material from the other (namely, those redundancies of local exudation which at last return as lymph to the blood) we have no alternative but to regard this material as the exciting cause of the secondary inflammation,—no alternative but to admit that the lymph of an inflamed part is imbued with contagious properties, which enable it in its course towards the circulation to become an irritant to the lymph-glands where it arrives.

Perhaps then it is not too much to surmise that the excitement of tissue which constitutes inflammation does (it may be, like heat and other dynamical excitements) essentially tend to diffuse and equalise itself; that the sympathy of continuous parts in one another's inflammation, that the sympathy of lymph-glands in the inflammation of parts whence they receive lymph, that the sympathy of the liver with intestinal pyæmia, that the sympathy of the lung with caval pyæmia, that the sympathy of numberless parts with aortic pyæmia, that the sympathy of the entire blood and thereby of the entire body in every larger inflammatory excitement, are cases which illustrate the operation of this tendency within the limits of a single organism; while the facts of gonorrhœal and ophthalmial contagion apparently show that the same power may operate beyond the first-affected organism, and that, at least under favourable circumstances, the products of common inflammation, transferred from person to person, can carry with them enough excitement to cause new inflammation where they go.

If then this be the case, what difference is there, in respect of the property of contagiousness, between common and specific inflammations? The materials for generalising on this subject are hitherto so imperfect that it would seem presumptuous to do more than suggest the following considerations:—

first, that in order for common communicable inflammation to be communicated from part to part or from person to person, no predisposition is requisite, nor apparently anything more than that the inflammatory products of the first part or person shall, while still living and active, have sufficient immediate contact with dynamical elements of tissue in the second part or person; whereas, in contrast to this, the specific inflammations cannot engraft themselves by cutaneous inoculation (any more than their inhaled ferments can become operative through the blood) except where certain textural predispositions exist;

secondly, that the contagiousness of common communicable inflammation seems to be in some special way relative to corpuscular development, and the contagium to be inherent in growing forms; whereas the contagiousness of the specific inflammations seems rather relative to their destructive acts, and the contagium to reside in defunct and dissolving organic compounds;*

thirdly, that in like manner the susceptibility to common communicable inflammation seems to reside in the common vitality of the germs of textural growth; whereas the susceptibility to specific contagions seems contingent (as will hereafter be shown) on the parenchymatous presence of lifeless or relatively lifeless organic compounds—compounds, which the various specific contagia, acting on them after the manner of ferments, can convert into their own respective likenesses and thus exhaust from the tissue which contains them; and

fourthly (as though by reason of these differences) that in the products of common inoculated inflammation, the predominance of pus is a marked and probably essential fact; whereas the specific contagia seem not to produce suppuration except by indirect inessential ways, and there are well-known cases where the products of specific inoculation tend to become inert almost in proportion as they become corpuscular.

(b) *Determining Causes of Inflammation considered with reference to their modes of action.*

Something may yet be said towards simplifying our estimate of the determining causes of inflammation. For when these influences are regarded from a physiological point of view—when regard is had solely to their respective modes of operation on the living body (and, of course, it is thus alone that they can be pathologically classified*), it seems that they are no longer so various.

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* Familiar illustrations of what is here and overleaf stated as to the specific contagia may be found in the microscopy of vaccine and variolous lymph, in their early, as distinguished from their later, stages. And recently Mr. Henry Lee (*Med.-Chir. Transact.*, vol. xlii. p. 450) dealing with the subject from an entirely different point of view, has noticed that simple inoculable chancres furnish a discharge of pus, while chancres which can produce secondary syphilis discharge nothing but débris.

Inflammation may have its starting-point from any undue production of textural death:—"*undue* production of textural death" because (as has been already stated) in every normal textural change *some* textural death is latent, some super-session of the organic material which acts, some going-away of what is effete, some place-making for what is new. From any *undue* production of this textural death, inflammation, it seems, may originate;—equally, whether the texture have received mechanically or chemically some direct and sudden deathblow of an instantly-disorganising kind, or have been more gradually brought to death by powers distinctly stimulant or depressant.

The characteristic power of stimulants and depressants over the textures on which they act—the power of simply causing those textures *to give more or less of their respective typical manifestations in form or function*,—this power belongs only to certain doses of the agent. When, for instance, increasing heat or increasing cold is applied to any part of the body, the result is, that, *within a certain range of temperature*, the heat progressively excites without otherwise changing, and the cold progressively reduces without otherwise changing, the normal activity of the texture on which it acts; but that if, in either direction, this range of temperature be exceeded, the texture no longer responds to different degrees of stimulation —no longer gives that essential sign of life.†

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* "With respect to classifying the acts and phenomena of the living body, whether in health or disease, the only true key lies in the thought of *Life as a power*: and a system of pathological classification will only then be perfect, when it shall admit of being verified and sanctioned *a priori* as a scheme of *dynamic possibilities* implied in the conception of Life. . . . As in the problems of pathology there are always two elements:—(1) impressions from without, as the causes of disease; and (2) the excitability of the subject as the liability to disease; so the principle I have stated assigns to us a double rule of procedure; namely, first, morbid phenomena must be generalised in the direction of the vital forces concerned in their production; secondly, morbid influences or causes must be contemplated, not in the multiformity of the outward world whence they originate, but in their relation to the living agent, whose excitability is the condition of their causativeness,—the living agent whose powers and functions they excite or depress, or whose organic material they modify." J. S., *Inaug. Lect.*, 1847.

† Model illustrations of this argument (at least as regards function) might be adduced from the actions of heat and cold upon the movement of the heart:—see some very interesting experiments by Dr. Pickford, reported

And as with heat and cold, so, it seems, with all kindred influences:—Beyond a limited range of operation (be it chemical, mechanical, or what not) the agencies of textural excitement, and the agencies of textural depression, become indiscriminately the agencies of textural death; bringing the affected elements of tissue into a state from which they cannot return to their normal irritability—a state, regarding which it now matters not whether it have come on them by over-stimulation or over-depression. For, they being essentially dead, the organ to which they belong can only (if at all) recover its effectiveness by substituting other elements in their place. And, as the need for substitution is of course proportionate to the void produced by death, so the consequent action ranges in magnitude from the greatest inflammatory processes to the impalpable doings of health.

Omitting for the moment such influences mechanical or chemical, as are instantly destructive and disorganising (though in fact they also fall within the scope of what is about to be said) every determining cause of inflammation acts primarily after one of the two patterns referred to:—like heat, it operates as a textural stimulant; or like cold, it acts as a textural depressant. According to these two types, the determining causes of inflammation must, at least provisionally, be classified.

Of the *depressant type*, our knowledge is much less than of its opposite:—so much less, that, were it not for the perfection of the typical case, we might hesitate to rest an argument on its reality. But with the analogy of cold to guide us,* we can scarcely doubt

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in his paper—*Ueber das Verhältniss der Hyperæmie zu dem Schmerze,* in Henl. u. Pfeuff. *Zeitschr. f. ration. Medizin,* vol. x. 1851. The same sort of thing in respect of ciliary motion (with isolated epithelial cells) is well shown by Mr. Lister in his paper already quoted, *On the Early Stages of Inflammation,* pp. 693-4.

* The writer, deeming it very important to be correct as to the action of cold in exciting inflammation, performed last March some experiments on the subject. Having occasion in hospital-practice to make some issues (such as are commonly made with potash or moxa) he used, in three cases, an application of solidified carbonic acid. With the intense cold of this contact (effected through a gutta-percha tube, and maintained in the three cases respectively for periods of 5½, 16, and 40 minutes) the skin almost instantly became so frozen as to ring like metal. In from 14 to 20 minutes after the application had ceased, the frozen textures had completed their thaw. Blood re-entered them. A swelling, singularly like that of urticaria, then occupied (but only transiently) the exact area which had been acted on, and was soon lost in a general puffy swelling which extended for some distance around. *With all this, the part was entirely without sensibility.*

but that the power of local anæmia to cause inflammation is exerted after the same pattern. Nor can we have difficulty in believing that drugs which depress the functional activity of textures may, in larger doses, be capable of killing the textural elements which they affect, and of thus becoming causes of inflammation.*

Under the *stimulant type* are included all the most familiar causes of inflammation:—not only heat, which (as before mentioned) when insufficient to inflame the parts on which it acts, increases their growth and promotes their activity; but likewise mechanical influences, which, in less degree than that wherein they irritate or destroy, may be used (as friction is habitually used) to excite healthy textural action; and chemical agencies—increased oxidation, for instance, which, if it be not enough to inflame, excites the healthiest manifestations of life.

By what method of operation it is, that textural death (however produced and in whatsoever proportion) becomes provocative of textural renewal, we know not. Respecting large palpable quantities, indeed, we constantly have opportunities of observing that dead texture is as a foreign body to the parts about it. But it would be hard to believe that inflammation arises only in the mere mechanical irritativeness of particles primarily killed. The laws of textural sympathy are so very imperfectly known to us, that strong assertions would here be out of place; but, even amid the obscurity, it seems an almost necessary expression of organic unity, that formative actions should arise in any segment of the organism in reparative response to sub-segmentary death.†

Inflammation presently set itself up in the surrounding parts; but the part on which the cold had acted remained without signs of life, and in due time (having suffered no inflammation nor recovered any sensibility) underwent separation as a slough.

* Undoubtedly this is the case with some drugs of the opposite class,—strychnine, for instance. This drug is not familiarly recognised as capable of inflaming the spinal cord, because, when it is given in sufficient doses to produce such an effect, the subject of experiment dies before inflammation can arise. But that such is its tendency may be inferred from the observations of Prof. van der Kolk (infra, pp. 82, 3) as to the microscopical state of the cord in animals poisoned with strychnine.

† Not only with reference to inflammation, but equally with reference to such hypertrophy as is illustrated in the over-growth of over-used muscle, and generally with reference to all similar actions, the ætiological formula seems to lie in these two propositions;—1) that textural waste is the provocative of textural renewal; and 2) that the effort of renewal aims at effects somewhat beyond an exact restitution of the wasted quantity of texture—aims at *restoration with increase.*

If this be so, we may expect that, in proportion as either a depressant or a stimulant influence becomes excessive and mortiferous to any portion of texture, the mother-texture will, as of necessity, be affected—yet affected in but one way :—that, whether a stimulant gradually excite the textural elements from hypertrophy to death, or a depressant gradually reduce them from languidity to death, in either case *pari passu* the mother-texture will be making its efforts of hypertrophy.

Hence, presumably, it is, that, in examining textures which have undergone a not too explosive inflammation, we find in profusion, among their dead elements, elements which, before death, had been engaged in efforts of over-growth. And hence likewise presumably it is, that, fading away into the distance all around any forms of inflammation, there are signs of simple hypertrophy unmixed with signs of degeneration.

2. *Predisposing Causes of Inflammation.*

There are certain influences, which, though not themselves essentially of an irritant kind, often co-operate with determining causes in producing inflammation ;—influences namely, which, if they have possession of the body before certain agents approach it, render it specially, or even distinctively and exclusively, liable to be inflamed by such agents ; so that the various amounts of inflammation excited in different persons respectively by equal quantities of a given determining cause measure the various degrees in which those persons respectively were subject to such predisposing influences. Likewise it is observed that inflammations produced in different persons by similar determining causes, differ, not only in the quantity, but to some extent in the quality of the process ; also that certain inflammations have specific peculiarities which cannot be exclusively referred to peculiarities in their determining causes ; and whatsoever in these various cases is differential or specific obliges us to infer the influence of differential or specific predispositions.

Under the title of "predisposing causes of inflammation" must accordingly be included all those influences which (other things being equal) make one man or one tissue apter than another either to initiate an inflammatory disease, or to suffer it in a particularly intense, or in a particularly spreading form, or with a particularly long duration, or with a particular tendency to recurrence, or with a tendency to develop particular properties in its products, or other particular phenomena in its course. In other words, the student must consider not only what predisposes to inflammation generally, but likewise what predisposes to special forms and varieties of inflammation.

The influences which may be most distinctly recognised as, in the above sense, predisponent to inflammation are the following:—chronic inanition, exhaustive diseases and old age;—local disease of arteries, local obstruction of veins, and local defects of innervation;—the fact of a part's having previously been inflamed;—an over-fed state of body;—the over-use of strong drinks;—the ingestion, by breathing or otherwise, of decomposing organic matters;—heat of climate, and perhaps other climatic conditions;—specific incidents of bodily development, either (as the so-called humoral dyscrasies) morbidly occurring in particular persons and families, or (as the several susceptibilities to certain febrile infections) normal to the human body at particular periods of life.

It is almost self-evident that these various influences could not conduce to the causing of inflammation, unless first, somehow or other, they acted in the very tissues which inflame. It is an instructive part of the study of inflammation to consider, even at some length, what is the nature of this local action by which each of them becomes efficient; for the result of such consideration is to render it almost certain, that, many and various as are the enumerated influences, their modes of operation are only such as one or two general principles can explain.

Molecular weakness of texture—not "weakness" in a mechanical sense, but "weakness" in the sense of "readiness to die under the action of stimulants and depressants,"—this probably is the prime local condition which predisposes to inflammation; and constitutional influences seem capable of conducing to the result, only in proportion as they lead to the local establishment of this textural weakness. The above-given list shows us indeed at a glance, that influences which notoriously are of a devitalising kind are also predisponent to inflammation; and detailed inquiry renders still more manifest the connexion which is thus suggested.

By lowerings of temperature which would not much affect healthy textures, the textures of the poor and aged and feeble are easily depressed to gangrene; and equally it is the case that they inflame under comparatively slight degrees of excitement. And as this inflammation probably starts from a too easy exhaustion and death of the stimulated texture, so likewise in its course it is essentially marked by the predominance of destructive processes; ulceration and gangrene tending in such cases to reach some of their highest developments. The chronic inanition of poverty (with the impoverishment of blood and consequently defective nutrition of tissue which it occasions) is effectually imitated, sometimes with further causes of textural weakness, in persons whom disease has exhausted; and in these persons, equally with the poor and aged, the textures are readily thrown into inflammation:—witness the facility with which a fever-patient gets bed-sores, as compared with some unexhausted patient (say, with simple fracture of the lower extremity) who lies, equally bed-ridden, beside him. Evidently too, as regards particular segments of the body, arterial or venous obstruction or arterial rigidity must occasion defects of nourishment very comparable to those which result from general starvation; and it is the fact that parts, having their circulation of blood thus interfered with, are, like common starved tissues, prone, when irritated, to considerable inflammatory destruction. That parts deprived of their normal innervation are predisposed to inflame, and that this inflammation is particularly apt to involve much destruction of tissue, are facts which already have been discussed; and in illustration of which it is only necessary here to quote the rapid and extensive gangrene which Sir Benjamin Brodie has seen arise in paralysed parts when suffering even the most inconsiderable pressure.*

It is very characteristic of all the influences now specially referred to as predisposing to inflammation, that (sometimes perhaps erroneously, but often also by right) they figure likewise among determining causes of the process. For, when pushed to excess, not only do they enable inflammation to be excited by determining causes which are almost inappreciably slight; but even they can themselves become direct causes of fatal textural depression, and thus secondarily develop that inflammatory excitement which arises where there is contact with textural death.

That textures which once have been inflamed are specially apt to inflame again, is partly due to the fact, that (particularly with dyscrasial inflammations) the old exciting cause is apt again to operate. Partly also it is due to the fact, that, in suffering inflammation, they may have permanently lost substance,† and thenceforth have become adequate only to lower functional requirements than before. But in part also it probably is due to the fact, that, in battling with the previous inflammation, not only were textural elements killed, but other textural elements were wounded and weakened; whence, during the survival of these damaged elements, slighter local disturbances suffice to re-initiate inflammation.

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* "After injuries of the spinal chord mortification from pressure is very readily induced. In a case in which the spinal chord is injured in the middle of the back, you may find, almost before you suspect that there is any thing wrong, a great slough over the sacrum,—nay, the pressure of the mattrass on the ankles will, in such cases, produce the same mischief. I have known mortification begin in the ankle within twenty-four hours after an injury of the spine." See Sir Benj. Brodie's *Lect. on Path. and Surg.* p. 309.

† With the kidneys, for instance,—supposing a quantity of structure to

Both with reference to some cases which already have been mentioned, and still more with reference to others which will presently be discussed, it seems highly probable that the textural predisposition to inflame is immediately dependent on chemical peculiarities in the texture. And the peculiarity which seems above all others to be influential for the result, is that kind of chemical mobility which depends on the texture's being at the time *saturated with certain unstable* (though quiescent) *products of textural waste.*

It needs not to be argued that the due defecation of the body is as important to it as its food. But perhaps the student may properly be asked to reflect on the immense amount and complexity of those molecular changes which silently and almost secretly minister to this process;—how the material of every acting organ changes in its every act, by waste as also by renewal; how products, which eventually appear more or less altered and oxidised in the breath and sweat and urine and fæces, are uninterruptedly being thus disengaged and, as it were, moulted from the living textures;—how, while the body grows its healthy growth, these declining products are incessantly merging themselves in the blood which washes past their source—merging themselves in it, not as urea and carbonic acid and excretin, but in impermanent forms infinitely more complex. Reflecting on those many runlets of textural drainage, each with its own protean constitution of effete devitalised material, he will easily conceive how important a mal-condition it may be, for any of them to remain stagnant amid the living substance, instead of continuing its progress to excretion; and he will be prepared to follow with interest the analysis of cases in which apparently this imperfect defecation of tissue constitutes the local predisposition to particular forms of inflammation.

" Specific incidents of bodily development, either morbidly occurring in particular persons and families, or normal to the human

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have been permanently destroyed by scarlatinal inflammation, any subsequent diuretic influence would have to work by the instrumentality of a smaller quantity of glandular structure. It would consequently affect that structure more intensely, and with more likelihood of causing inflammation, than if it were operating on the original amount of gland.

body at particular periods of life," were cited among influences which predispose to inflammation. And, since those developmental conditions are probably of the kind just referred to, the proposed analysis may conveniently begin with them; taking, to illustrate the two sorts of conditions, first, the pathology of gout, and secondly the pathology of those eruptive fevers which happen to most persons once, but only once, in life.

Gouty inflammation is characterised by an explosive local appearance of uric acid; and, on consideration of the circumstances under which this explosion occurs, the inference seems certain, that materials transformable into uric acid were previously accumulated in the texture which inflames. Perhaps this conclusion might not seem fully justified, if regard were only had to the cases in which gouty inflammation begins without any known action of a determining local cause; but when we see that, in podagrous subjects, any common irritative influence (a blow, a sprain, an overwalking) which causes the foot to inflame, causes it to inflame specifically,—causes, that is to say, an explosive appearance of uric acid where, in common inflammation of equal intensity, there would be merely disintegrated tissue, we cannot but apply this fact to the elucidation of obscurer cases. Further, the local facts of gout have to be considered in connexion with certain points in the general chemistry of the gouty body:—and among such points the one of most present interest is, that habitually during the incubation of gout, marking its anteparoxysmal latency, there is an imperfect urinary defecation of the system. That an imperfect formation of urinary constituents is at the root of this imperfect discharge of them, seems in the highest degree probable. Taking then summarily (so far as relates to our present subject) the facts of gouty inflammation, it seems that certain nitrogenous matters which ought continuously to flow off more or less oxidised by the kidneys are, in persons of gouty habit, apt to be withheld from their final conversion; that in this state of interrupted transformation, wherein perhaps their solubility and transudability are imperfect, they linger saturatingly in those textures of the body (most of all in extreme parts) where their conversion has been slowest, and probably to some extent also in the blood; that this storing-up of certain unripe ingredients, or rather antecedents, of the urinary excretion constitutes the textural predisposition to gout; that presently some pyrexial or other influence, local or general, acting as a sudden stimulus to the languid transformative energy of the part and overcoming its chemical indolence, initiates that explosive decomposition into urinary ingredients which ought to have been continuous and gentle,—a decomposition, which, thus beginning in a part, spreads in its own sort to what kindred material there is in the blood (infecting it with a modified inflammatory fever) and thence extends its contagion to other organs which are similarly predisposed.

To place in its proper light the nature of that continuous chemical languidity by which textures are prepared for the crisis of a gouty inflammation, one fact more must be stated. The tendency to gout is hereditary. The plan of constitution and development which every organism derives from its parentage belongs to its chemical not less than to its anatomical being. And, just as the visible forms of the body shape themselves according to an inherited pattern, thus, no doubt, also in the chemical functions are there likenesses of offspring to parent,—likenesses in the rate at which tissues waste into excrement, likenesses in the chemical forms through which they pass, likenesses in the tendency to particular inactivities and abortions of chemical development and decline, likenesses accordingly in those textural predispositions to disease which are constituted by imperfect defecation of texture.

In the chemical contrast which subsists in gout between the paroxysm and the inter-paroxysmal state, perhaps (we repeat) gout may be the type of a class of diseases. For other diseases there are, which, like gout, have for their essential character, that textural excitement comes on fitfully—sometimes with almost explosive violence; as that excitement of a nervous centre which makes the paroxysm of epilepsy or mania, and that excitement of articular or serous membranes which marks the attack of rheumatic fever. Such faint indications as chemistry can yet afford on the subject, suggest it as not improbable, that these diseases may be analogous to gout in the general significance of their phenomena;—that some impermanent form of textural refuse, locally arrested and accumulated and acquiring chemical tension, may, hêre as in gout, be the gist of the inter-paroxysmal state; and that an explosive escape from this morbid repose may be the essential fact in a paroxysm. In the present state of chemical knowledge, these matters must be spoken of with uncertainty; but what may more confidently be stated is, that any paroxysm of the diseases referred to involves an inflammatory change in the affected texture,—a vehement and obvious inflammation in the case of rheumatism, a stealthy and microscopical inflammation in the case of epilepsy* or mania; that the predisposition to this inflammatory process is of gradual increase before the attack; that the paroxysm is a crisis of intenser chemical action, involving increased discharges (perhaps specific discharges) from the body; and that with these diseases, as with gout, probably for the same physiological reasons, the peculiar constitution which predisposes to the paroxysm is one which tends to repeat itself according to the laws of hereditary succession.

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* Professor van der Kolk, after poisoning dogs with strychnia, has found

The well-known phenomena of smallpox may be referred to as illustrating what, during our present state of knowledge on the subject, may be considered a second specific kind of textural predisposition to inflammation;—that kind, namely, where common exciting causes of inflammation do not seem capable of causing the part to inflame specifically; but where, for the production of this result, it seems necessary that a specific exciting cause should co-operate with the specific textural predisposition. During the febrility of smallpox, the patient eliminates (probably in various states or stages of change) a quantity of material which previously was in the texture of his integument, and in losing this material he loses his susceptibility to smallpox; but in order to undergo the pustular inflammations and attendant waste of material which characterise smallpox, it seems that the predisposed integument must (either by inoculation or through the blood) have been acted on by the waste-products of a similarly predisposed integument already thrown into its course of specific change—in other words must have been contagiously affected by the morbid poison or ferment of smallpox.

Smallpox is so typical a case of specific contagious inflammation, that the student will do well to consider its facts somewhat minutely in detail.* And what he thus learns of the predisposition to vario-

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the gray matter of the spinal cord in the lumbar region presenting numerous small effusions of blood; some capillaries having given way, while others in their neighbourhood were distended to the verge of bursting. And the description which he gives of the state of parts of the medulla oblongata in persons who have suffered from epilepsy seems to show that the epileptic paroxysm involves an almost equally vehement determination of blood to the affected nerve-texture, and often leads to similar rupture of capillaries. It is noticeable that in each of the strychno-tetanic effusions he found a lighter central part, "where (he says) perhaps the blood is diluted by the subsequent issue of serum;" but for which perhaps earlier parts of the present paper may suggest a different explanation. See his work on the *Minute Struct. and Funct. of the Spinal Cord and Medulla Oblongata, and on Epilepsy*; transl. (New Sydenh. Soc.) by Dr. Moore.

* The following quotation on the subject discussed in the text is from a lecture published by the writer in 1850, but is taken with a few verbal corrections and with this modification:—viz. that whereas, in the original,

lous inflammation may be applied, *mutatis mutandis*, to the pathology of measles and scarlatina. With these diseases, as with that, a specific texture-held chemical compound (representing some impermanent, though for the time stationary, product of textural waste)

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the *blood* exclusively is mentioned as the seat of the material which predisposes to specific contagions, the writer, in transcribing, has altered all passages which imply this doctrine, and has substituted words which imply his present belief (adopted very soon after the publication of that lecture) that the blood does no more than participate in the possession of that predisposing material, and that the textures which are respectively acted on by the specific contagion are themselves the main seats of its accumulation. "You receive, perhaps from a long distance, a lancet, on the point of which is a little dry animal matter. This lancet has pricked the pustule of a patient suffering with smallpox, and the contents of the pustule have been allowed to dry on the lancet. Now, with this lancet, you make a single puncture in the arm of a healthy person, not previously defended by vaccination or otherwise. And what results? On the second day after the operation (says Dr. Gregory) if the part be viewed with a lens, there appears an orange-coloured stain about the incision, and the surrounding skin seems contracted. On the following day a minute papular elevation of the skin is perceptible, which on the fourth day is transformed into a vesicle with a depressed centre. The patient perceives an itching in the part. On the sixth day some pain and stiffness are felt in the axilla, proving the absorption of the virus into the general mass of blood. Occasionally on the seventh, but oftener on the eighth day, rigors occur, accompanied sometimes with faintishness, sometimes with pain in the back, headache or vomiting. The patient complains of a disagreeable taste in the mouth, and the breath is offensive, soon after which the eruption shows itself. If the patient have been a woman, and pregnant, her fœtus will generally have been affected, and if so, will have died. Finally, when the eruption has developed itself, you find that every one of these new pustules inherits the infective power of that from which they were developed; and thus from one patient you can obtain enough of the morbid poison to diffuse smallpox throughout the habitable globe in an inconceivably short space of time. Observe this immense increase of material: remember the almost imperceptible stain on the original lancet: here you have its material reproduced by a thousand-fold—a million-fold multiplication. Your patient having recovered, suppose you try to infect him again in the course of a few months. You charge your lancet; you make the puncture as before; or you make half a-dozen; you accumulate all means of infection about the subject of your experiment; but no longer will he give a single sign of the specific affection. You have got from him all the phenomena he can give in answer to that particular reagent. I may compare his change of condition to this: —suppose you had a tumbler full of a solution of carbonate of soda, and added an excess of nitric acid; you would get vehement effervescence, more or less, according to the abundance of your dissolved carbonate, and continuing till it had effected the complete disengagement of the gas: then —that particular moment having passed, you might add nitric acid *ad infinitum*, but not another bubble would rise. Just so, your patient refuses apparently constitutes in each case the respective textural predisposition:—as the skin inflames with smallpox only because it contains and only while it contains, in combination with its texture, certain effete material, so the tonsils and kidneys inflame with scarlatina only because they contain and only while they contain, in combination with their texture, certain other effete material; and so forth.

Generally, respecting these textural predispositions to be inflamed by morbid poisons, and by most of them (as a rule) to be thus affected only once in life, the probable argument may be thus summed up. In the first evolution of certain textures, there normally arise certain waste-products, which, it seems, under ordinary circumstances, are difficult of destructive conversion, and therefore tend to an indefinite loitering in the part or in the system. As

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to effervesce any more from new infection; certainly for a long time; perhaps for the rest of his life. You re-apply the same cause as produced the phenomena before—identically the same material; and you get a different result. This fact conclusively proves that a change has occurred in the subject of your experiment; a change in him has altered his relations to an unchanged exterior cause; by this personal change the poison is rendered inert to him, while it retains its activity towards others. We have it accordingly demonstrated, that for the production of the disease there must be a *specific internal*, as well as a specific external condition; that the former is liable to be exhausted; and, as it becomes exhausted in the production of material phenomena (namely, in the generation of pustules) therefore, obviously, it must itself be a something material, like that outward condition with which it co-operates; that, as the contagium of smallpox is a something material and tangible, so the susceptibility to smallpox is a something material and tangible. Of this predisposing material, whatever it may be, no trace remains in the body when the disease has completed its course: and, since the skin and mucous membrane have been the seats of those inflammatory changes amid which it has melted away, there seems every reason to believe that they were its essential seats. It would further seem probable that the blood must to some extent participate in the same possession; that thus it is able to communicate the influence of inoculation from that part of the integument which has the primary pustule to those other parts which pustulate four or five days afterwards; perhaps also itself to receive direct infection from inhaled contagium, and even in certain cases to develop poisonous products with such rapidity as to destroy life before cutaneous pustulation can begin. Thus we get a general formula for the pathology of smallpox;—a certain organic ferment (A) soluble and partially volatile, affects particular relations with (B) an ingredient of the integument and blood: the results of their coming together are the utter destruction of B and the immense increase of A. On the one hand, the contagium augments so much that it is found all over the body, constituting innumerable pustules, and contaminating the breath with its volatile miasma; on the other hand, the inward natural ingredient of the body simultaneously diregards each such stuff respectively, one particular stimulus is always effectual to convert it,—the contact, namely, of similar stuff already thrown into its specific process of decay. Let this stimulus remain absent; and the subject retains, even apparently to the end of life, the peculiar susceptibility which it alone can awaken and extinguish.* Let the stimulus come,—and forthwith the stagnant material ferments more or less explosively, commonly with destruction of tissue, often with destruction of life; passing, while it wastes from the body, through a stage of contagiousness similar to that which has stimulated its own change; and leaving the body, when this discharge is accomplished, more or less permanently incapable of renewing the process, or at least only so far capable of renewing it as the predisponent material is capable of being renewed.

It has been intimated that the specific predispositions here spoken

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minishes, and at the end of the process is found totally exhausted. Look at this as a chemical experiment: you add A to B; presently you find that B has vanished and that A has undergone an immense augmentation. What is the meaning of this? What has become of B? Whence has the new A been derived? It is difficult to avoid the conviction, which arises with almost logical certainty, that the increase of one material and the decrease of the other have stood in essential mutual relation; that, in short, it has been a process of conversion; that the essential relation of the two matters (that derived from without, and that contained within, the body) has consisted in the ready convertibility of one into the other; that the specific power of the contagium is its fermentative power of effecting this transformation, and no other. Finally, while that convertible matter, on which the contagium of smallpox effects its assimilative change, does without doubt *normally* form part of the susceptible integument and blood, yet assuredly it is no *essential* constituent of them; for the patient who recovers from smallpox, though with no demonstrable trace of that constituent in his body, returns to at least as good health as before. It may be added, too, that in a certain very small proportion of persons, this natural susceptibility to smallpox appears not to exist."

* The existence of that specific stimulus may reasonably be considered to have been an accident in the pathological history of man; for millions, no doubt, have reached the natural term of life, healthy in mind and body, to whom measles or smallpox or scarlatina has never come, but who to the very last moment have retained their susceptibility to the disease. And of two alternatives it may perhaps rather seem to have been contemplated, in the scheme of construction for man, that the ingredients in question should indefinitely remain in his body, as inactive, indifferent constituents, than that, for a normal process, they should be worked out of him by the fiery ordeal of fever. When the contagion of measles after an absence of 65 years was imported into the Faroe Islands, the disease did not show itself as an infantine epidemic, but as an epidemic equally affecting all ages which were junior to the last visitation.

of are normal facts in the development of the body. To this rule indeed there may be exceptions, as to other rules in the same category. Just as, by faulty development of bodily forms, harelip or spina bifida or twelve fingers or webbed toes may occur as an exceptional phenomenon; so the chemical development, it appears, may exceptionally omit to complete, or not less exceptionally may hasten to renew, some one of the organic compounds which are respectively fermentable by the several morbid poisons. Such exceptions, however, like the rule itself, mark the developmental source of the predisposition. Either by falling short of what is normal, or by going beyond it, a child may be excepted from the rule of liability once in life to variolous, rubeolar or scarlatinal inflammation, as he may be excepted from the rule of having ten fingers, or from the rule of having an uncleft palate: and in either case the peculiarity tends to be hereditary. As it is with the one child, so it probably is with his brothers or sisters or some of them, and so it probably was with one or other of his parents:—it is part of the family-likeness among them, that they do not develop the stuff which makes the liability to measles, or that they develop again and again (if it be removed by successive fermentations) that other stuff which makes the liability to smallpox. The tendency of particular families to suffer particular infections with unusually great, or unusually slight, severity, is another fact of the same signification.

The kind of predisposition to inflame which consists in the textural accumulation of unstable chemical compounds is perhaps further illustrated by other influences in our list.

When, for instance, we have the fact before us, that great consumers of strong drink on receiving slight local injuries (especially if the injury be such as to create an open wound) are apt to suffer severe sloughy inflammation, we cannot but advert to what now seems well established respecting the action of alcoholic stimulants, —that they retard the excretory changes of tissue, and tend to produce an artificial diathesis in which the organic substance is unduly loaded with refuse. Similarly, that kind of albuminous plethora, which exists in persons who over-feed and under-exercise their bodies, is probably inconsistent with a due defecation of the system: and this consideration, naturally connects itself with the fact, that such persons are peculiarly susceptible of bronchial and muscular inflammations.

So, again, when we see the infants of the poor in crowded town-dwellings suffer many times the mortality which is natural to their period of life, and this mortality mainly from inflammations, we are reminded that, in the animalised atmosphere of those dwellings, respiration can furnish no due excretory cleansing to the blood, nor adequately assist the tissues to get rid of their effete elements.

The characteristic intestinal inflammations of cholera and typhoid fever, excited as each of them is by a specific ferment which develops itself in the decomposition of excrement, strongly suggest the existence of specific textural predispositions, natural or to some extent acquired, and founded on the textural presence of half-eliminated excremental material.*

Even in that already-discussed predisposition to inflame which is evinced by ill-nourished textures, and still more in that heightened susceptibility to typhus which arises under the influence of starvation, it seems probable that the chemical conditions are of the kind now spoken of, and, at least in the latter case, are of essential importance to the result.†

That, under many of the circumstances here adverted to, there actually does prevail in certain materials of the body a less than normal fixity of chemical constitution, is not altogether a conclusion from analogy. A very curious generalisation bearing on the subject has recently been published by Dr. Inman* of Liverpool, to the effect that during many states of debility the patient's excretions are preternaturally prone to decomposition. Dr. Inman especially refers to the alvine discharges, to the urine, and to the organic matters which are eliminated with the breath. And so little is this generalisation an effort of medical theory, that Dr. Inman refers his first reflections on the subject to a hint given him by a chemist twelve years ago, during some experimental deodorisations of excrement; for the operator professed to estimate the magnitude of illness with which patients were suffering, by the various amounts of putrefaction which their excrements (some hours after evacuation) had undergone; and he alleged that "he had found, in the course of his experiments, that fæces decomposed rapidly or otherwise, according to the debility of the individual passing them."

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* Parts of the mucous membrane of the intestinal canal serve as a great disinfectant influence for the blood: fœtid contaminations of the body almost invariably excite diarrhœa; and it is a well-known observation of dissectors, that, in flatus voided from their bowels, they can recognise the distinctive stench of whatever putrefying matter they may have been busied with,—of human gangrene, for instance, or (as the case may be) of porpoise, cuttle-fish or dog. It is therefore probable that, in persons habitually exposed to putridity, those parts of the mucous membrane of the intestines are constantly in a state more or less approaching saturation with impurities. The urban poor, for instance, frequently dwelling in crowded, unventilated, filthy places, where they breathe a fæcal air and sometimes also drink a fæcal water, present one great type of such cases; and whatever chemical changes can occur in fæcal matters removed from the system, may reasonably be expected to affect, in persons thus circumstanced, that intratextural excess of fæcal or half-fæcal matter, with which the eliminating parts of the intestinal surface are charged and sodden. How greatly such persons suffer from the various diarrhœal infections is now well known. Probably the relations of cholera and typhoid fever to specific putrefactions of excrement is as definite as that of smallpox infection to smallpox virus; and the affection of the intestinal mucous membrane by the diarrhœal ferments represents the extension of a putrefactive process from refuse matters without the body to refuse matters within it.

† No such ravages have been made by typhus as when it has been associated with famine and, apparently by reason of this association, has prevailed as a national epidemic. There are analogies between the state of persons dwelling in foul atmospheres and the state of persons suffering starvation.

Finally, with respect to the climatic conditions which predispose to inflammation, it seems probable that they act only by affecting that chemical mobility of which so much has been said. Thus it may be that continuous atmospheric deficiencies of ozone predispose to those inflammations which are contingent on imperfect defecation of texture. And thus apparently it is, that heat of climate greatly favours the outbreak of all inflammations which arise in anything like putrid infection; as is illustrated by Magendie's statement † that, by injecting into the blood-vessels two grammes or even one gramme of putrid material, during very hot weather, he could produce death as certainly as by injecting three, four, or even ten grammes during winter.

"The starved body, which cannot renew the waste of its texture by the ordinary resources of food, probably ekes out its being and maintains the continuity of its organs by stuff, which, under ordinary circumstances of nutrition, would have been discharged as effete. Thus, probably, it comes to consist to an abnormal extent of stale material in a state verging on dissolution. And just as the rags of poverty may by a touch be torn asunder, so those half-starved tissues which they cover fall under very small injuries into disproportionate ulceration and gangrene. The fact that during times of famine masses of population are found with their textures and juices in this state (undefecated because unrenewed), may perhaps have something to do with their fatal susceptibility to typhus; for, under such circumstances, the contagion of this form of disease will spread and multiply (like the contagion of smallpox amid an unprotected population) at a rate quite disproportionate to the sanitary defects of localities." *Papers relating to the Sanitary State of the People of England*, 1858; p. xvi.

* *Foundation for a New Theory and Practice of Medicine.* London, 1860; p. 214.

† *L'Union médicale*, 1852, p. 236.

D. PATHOLOGICAL SUMMARY.

It may be convenient, before closing the present large division of our subject, to review the principal conclusions which its argument seems to justify.

The phenomena of inflammation are modified phenomena of textural life. The modification is primarily one of quantity:—the phenomena are in excess; but, because of their excess, they tend to be unelaborated and crude. Change of material is striven for more rapidly than normal change can complete itself.

This excess, but incompleteness, of textural change shows itself anatomically in two concurrent signs; one belonging to the category of textural decay, the other to the category of textural renovation.

On the one hand there is *effete material*, *unremoved*,—material, disappropriated and brought to death quicker than it can impalpably melt away:—hence " sloughs" and " desquamation" and " débris" and " softened" and " degenerated" tissue.

On the other hand there are *nascent forms*, *unapplied*,—forms, which express a profuse but unconsummated textural growth,—forms, which have resulted from intra-textural germination, but have either perished before maturity, or have definitely ripened into mere abortions of texture:—hence " irritative hypertrophy" and " degenerating endogenies" and " inflammation-corpuscles" and " mucus-corpuscles" and " pus."

The action whereby inflammation begins is one which physiologically cannot be distinguished from hypertrophy. The line of distinction is drawn, where the effort of hypertrophy becomes abortive, and where the forms of increased growth are mixed with palpable refuse of increased decay.

From simple autopathies of texture, inflammation is distinguished by its compoundness:—simple hypertrophy does not evolve profuse waste-products of degeneration; simple degeneration does not provoke an excessive textural productivity; it is the union of such opposites, which makes the diagram of inflammation.

Cancer and inflammation have the most intimate morphological affinity; and probably what is distinctive of cancer lies far less in the nature of its textural phenomena, than in the hitherto unknown causes which give them their fatally continuous progress.

With the hypertrophic textural changes which are introductory to inflammation, there is invariably, though as yet latently, an increased textural waste:—as cells begin to germinate, intercellular material begins to pass away. Tested, however, by visible forms, the hypertrophy always seems to spread more widely than the waste; and there are cases where inflammatory loss of substance and inflammatory reproduction, though concurrent and correlative, seem abruptly set apart in different zones of texture.*

The inflamed part, with its increased textural change, is increasedly productive of heat. Through its veins and lymphatics it increasedly contributes to the circulating blood both heat and changing material.

Inflammation determines hyperæmia. When the textural changes begin, the elements of texture become increasedly absorbent of blastema, and suck more than commonly from the capillary circulation:—hence "effusion" or "exudation" into or onto an inflamed texture; hence also the "stasis" of corpuscles within any capillary channel which is thus deprived of its scour. To provide, during local necessity, for this greater local appropriation of blastema, greater afflux of blood is required:—in inflammation (as in simple hypertrophy) the ministerial blood-vessels accordingly dilate, and ampler supplies are transmitted through them.

Inflammatory "effusions" are derived, not indifferently, but electively, from the blood:—the inflamed texture appropriating in excess those chemical ingredients which it requires for its germination.

The so-called "four symptoms of inflammation" are such signs as can during life be best perceived, of increased textural change:—*heat*, as its necessary concomitant; *redness* and *swelling*, as the expressions of attendant circulatory and transudatory changes; *pain* as the measure of nerve-injury subsisting in the local process. Further essential symptoms may be produced, primarily by the *functional excitement*, subsequently by the *functional inaction*, of the particular organ inflamed.

Inflammatory excitement tends to diffuse itself. Within limits hitherto not defined, inflammations, both common and specific, are communicable from part to part and from person to person. "Sympathetic inflammations" are facts of inflammatory contagion. "Inflammatory fever" is a total bodily infection wrought by materials from the inflamed part.

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* When we cut across a vertebra, deeply excavated by aneurismal pressure, it looks as though the remoter half of the vertebra had doubled itself with condensative growth, while the other half was vanishing with ulceration. And in indolent ulcers of the leg, we see the central punched-out space of sore, with flat inactive surface, limited by an abrupt edge where often there is much overgrowth.

Inflammatory fever consists in an unduly hot and changeful state—primarily of the blood, secondarily of all blood-supplied textures. The symptoms of inflammatory fever are the signs of this greater heat and change.

Inflammatory excitement may be caused by the excess of any influence, which, in minor operation, would healthily increase or healthily diminish the acts of textural life. In either case (whether of over-stimulation or of over-depression) the primary effect is, that textural death is produced. And textural death, whatever may have been its cause, is necessarily a starting-point for inflammation.

Influences which respectively can stimulate or can depress textural life are (so far as we know them) powers which respectively can promote the chemical change, or can give fixity to the chemical constitution, of textures on which they operate.

Textural predisposition to inflame is a form of vital mobility in the texture,—a form, which probably in every case corresponds to conditions of chemical mobility in the texture.

Inflammation is of course in all respects commensurate with its causes. In proportion as they are long-lasting or recurrent, so is it chronic or relapsing; in proportion as they cease to operate, so do its destructive processes arrest themselves,—degeneration becoming confined to superfluities which have to waste away, and production, with lessened rapidity, conforming itself to services of repair. In proportion as textural predisposition is extensive or intense, inflammation spreads more diffusely from the part where its determining cause first operated, or wreaks itself on that part with more destructiveness.

The power which produces the phenomena of inflammation is the power which produces the ordinary phenomena of textural life: and fully to explain Inflammation would in fact be to explain Life.

Finally, it may be of interest to observe that whatsoever of the above conclusions is of most fundamental importance to the theory of inflammation is, in principle, not peculiar to this section of pathology. The laws which regulate inflammation regulate all other disease; and the illustration here given of them lies all within the terms of those few large generalisations which increasing experience tends more and more to establish as the basis of scientific medicine:—

that morbid phenomena, in proportion as they are vital in their kind, consist in merely quantitative or gradative excesses or deficiencies of normal growth or function;

that all residual phenomena of disease express the supremacy of physical influences, to which the affected bodily material is more or less passively surrendered, and by which its natural decay is quickened, retarded or modified;

that influences, directly causative or contra-causative of disease, cannot produce results otherwise than under these conditions,—cannot primarily do more than increase or diminish, in whatever active texture they affect, the texture's typical doing, formative or functional,—cannot primarily do more than qualify, in whatever passive organic material they affect, the material's passive transformation.

III. The Treatment of Inflammation.

A. GENERAL PRINCIPLES.

Subject to explanations which will presently appear, it may be said that the treatment of inflammation has for its immediate aim, *to reduce that excitement of tissue which essentially constitutes the disease.*

And our endeavours to attain this object—endeavours, so various that the detail of them can here be only partially attempted, may (as regards their nature) be generalised under two heads which express the main rational rules of antiphlogistic treatment. These rules are the following:—

(1) with careful regard to all influences which are operating on the inflamed part, to procure the discontinuance of the special cause of the inflammation, and, as far as possible, to relieve the part from the action of other stimulants; and—

(2) by direct and indirect action on the inflamed part, to counteract there, as far as possible, the working of such irritant causes as remain in operation.

Concurrently with all treatment of inflammation, this (3) object also has to be fulfilled;—that the organised products and waste-products of the disease, and generally its complications and consequences, be so dealt with as to prevent them from re-acting hurtfully on the part, or originating other mischief to the body.

1. *To relieve the part from causes of excitement.*

That *inflamed parts, as soon as inflaming causes are withdrawn from them, spontaneously tend to recovery*, is a truth, which—simple and rudimentary though it appear, is of more fundamental importance than any thing else which can be said in reference to the treatment of inflammation. And if our knowledge of the causes of inflammation were complete, all other than ætiological principles of cure would become relatively insignificant.

Under present circumstances, however, there is but one group of cases in which inflammation is knowingly and habitually cured by the mere withdrawal of its cause; and fortunately for the surgeon this group lies for the most part within his province of practice.

The chronic inflammation which is produced in the mucous membrane of the bladder by the presence and friction of an urinary calculus, the acute inflammation which begins in the cornea when some small fragment of steel is driven into its texture, the repeated suppuration and inveterate sinuses which attend the deep-seated retention of any foreign body, or (as operating in the same way) of sequestra of dead bone,—these are common illustrations of the group of cases referred to. Not all the pharmacopœia of antiphlogistics is so effectual in these cases as the mere mechanical act of removing the calculus, the splinter, or the sequestrum.

The thickening, and eventually the ulceration, of skin which (as in the course of ordinary corns) result from undue pressure and friction on the surface; the inflammation of subcutaneous bursæ under similar circumstances; the nebulous state of cornea, produced by the scrubbing-brush of inverted eyelashes; the ulcers which arise in the varicose leg from the stagnifying vertical pressure of an unvalved column of blood; the bronchitis which associates itself with those various kinds of factory-labour wherein the workman has to inhale mechanical or chemical irritants;—these are further familiar cases, where morbid conditions are essentially co-enduring with their respective tangible causes, and are best treated by the removal of those causes. Taking from among them, for example, the case where an ulcer of the leg is enlarging and deepening itself day after day by uninterrupted acts of inflammation;—let the patient be confined to bed with his leg horizontal or raised:—no sooner is the local circulation thus relieved from its previous mechanical impediments, than inflammation ceases in the part, and the foulness of the sore almost immediately gives place to healthy granulations, which attest the commencement of repair.

It is among the highest problems of pathology, to discover new groups of cases capable of being treated, like the above, by the simple removal of their respective causes. With the various dyscrasial inflammations, for instance, which are now treated exclusively from an empirical basis and consequently often without success, how great an achievement it would be, if their immediate causes could be made as palpable as the mechanical causes just spoken of, and could, like them, be distinctly aimed at and destroyed!

Only second in importance to the principle of procuring, where possible, the discontinuance of the special cause of the inflammation, is the kindred principle,—that the inflamed part should be as far as possible relieved from the action of other stimulants, and from all inconveniences of posture.

Setting the inflamed part thoroughly at rest, as regards the exercise of its own functional activity, is one great step towards fulfilling this rule. It is thus that, with so much advantage, we exclude from an inflamed eye the natural stimulus of light. It is thus again that in the case of inflamed joints (especially where there is subarticular caries) the simple expedient of thoroughly immobilising the part by the application of an appropriate splint will often give chances of recovery which cannot otherwise be attained.

But further,—so intimate is the sympathy between all component parts of the living body, that, in order to get the fullest measure of repose for any one organ, it is requisite that other organs be restrained from exercise. In proportion as an inflammation is considerable—especially in proportion as it is attended with febrile symptoms, we find it of importance to obtain thorough quiet for all the animal functions; to reduce to a minimum all muscular movements, all impressions on the senses, all appeals to the intellect or feelings, and all exertions of the will. Probably every inflammation admits of being treated to most advantage when the patient is kept entirely recumbent; but at least in every case where there is appreciable feverishness, it is essential that the patient keep bed, in a cool and well-ventilated apartment, with every kind of disturbance excluded, and with every available facility for sleep.

It is necessary that the inflamed part be not left in a dependent or constrained posture, but be sufficiently raised to favour its return of blood; and that, by appropriate covering, it be kept free from all irritative contact.

Any existing mal-condition of body by which inflammation or fever may be aggravated will of course at the same time be attended to. And although purgative medicines ought not to be given as a matter of routine, the surgeon will always have regard to the state of the bowels, and particularly will see that vitiated secretions be not retained in them.

2. *To depress the local action and obviate its hurtful consequences.*

The treatment hitherto spoken of is, in principle, preventive. The treatment now to be discussed—the treatment, to which recourse must be had when the progress of inflammation can no longer be prevented by the removal of its determining cause, is, on the contrary, of the nature of an antidote. The cause, not being removable, we have to counteract its effects:—to counteract them primarily, as they consist in the local excitement; to counteract them secondarily, as they consist in results which the local excitement originates.

In this curative treatment of inflammation and its results, the following objects (or some of them) are aimed at:—

(*a*) by depressants and sedatives, either (like cold) outwardly applied to the inflamed part, or (like opium) administered to it through the blood, to directly reduce its excitement and irritability;

(*b*) by stimulants applied to uninflamed parts of the body, to create counter-excitement, which (as regards attractive influence on the blood, and perhaps also as regards other conditions of existence) shall outbalance the excitement of the inflamed part,—or by other derivative means, of which local bleeding is the principal, to attract into collateral channels the flow of blood which otherwise would feed the inflammation;

(*c*) by general depletory measures—of which bleeding and purging are the principal, and by withdrawal of food, and by use of emetics or nauseants, so to impoverish and weaken the general circulation, that the entire body (including of course its inflamed part) shall be brought into circumstances of scantier nourishment, and be freed from vascular tension;

(*d*) by febrifuge treatment (not necessarily depletive) to relieve the blood from sympathetic derangement, and render it in temperature and constitution as capable as it can be of contributing to resolve the inflammation.

Further, with reference more particularly to special symptoms or results of the inflammatory process, or to special varieties of inflammation, we may propose to ourselves one or more of the following objects:—

(*e*) by cutting into an inflamed part, to relieve it from extreme vascular tension,—or, by uniform mechanical pressure on an inflamed part, to promote the emptying of its vessels;

(*f*) by cauterising or intensely irritating an inflamed part, to break the continuity of its particular morbid process;

(*g*) by the use of antiseptics, locally or generally, to cleanse the sources, and obviate the evil results, of putrid infection;

(*h*) by surgical operation, where admissible, to effect the discharge of collected inflammatory fluids, and the removal of gangrenous parts, or of parts rendered irreparable and inconvenient, or of parts which threaten life;

(*i*) by the use of narcotics, to procure the discontinuance of extreme pain;

(*k*) by the use of specific drugs, to counteract specific dyscrasial states;

(*l*) by the use of mercury, to develop such a constitutional state as will resist the formation, or cause the destruction of false membranes and adhesions;

finally, with respect to parts where only the consequences of inflammation remain,—

(*m*) to excite by stimulants, so far as deficient, the local actions of defecation and repair.

(*a*) 1. To no exterior influence is textural excitement so directly amenable as to changes of temperature. COLD, continuously applied, is the sedative of every vital manifestation. Under its influence, rhythmical actions become slow or null, sense and volition slumber, reflex phenomena cease, common growth and embryonic development alike stand still, injured parts are unable to repair themselves.

In theory, then, it may be said that continuous cold, locally applied, is in direct and essential opposition to the causes of inflammation. But in practice it is by no means common that cold can be thus used as an antiphlogistic.

Not only are there many cases of inflammation (internal inflammations, for instance) where it is mechanically difficult or impossible to apply the agency of cold; not only are there many other cases (exanthematic inflammations, for instance) where the external repressant is deemed dangerous to life; but, further, the principle on which continuous cold operates is such that, even with external traumatic inflammations, somewhat narrow limits must be assigned to its use. Though clinically it is not always easy to fix these limits with precision, the guiding thought may probably be thus expressed;—that, as continuous cold is rather an antidote to the causes of inflammation than a remedy for the resulting changes, so, in order to get full advantage from its use, we must employ it almost from the moment when the causes begin to operate. Thus used in cases to which it is applicable, cold serves as it were to subtract something from the efficiency of the exciting causes of inflammation, and to regulate, from its very start, the momentum of the inflammatory process.

In conformity with the above principles, cold is of great antiphlogistic value in the treatment of wounds; perhaps especially of such as are made in surgical operations. Here, commencing its employment almost from the moment of injury, and thus continuously moderating the local temperature, we are enabled to restrict textural activity within the limits of what is just necessary for the adhesive process :—to restrict it in degree, so that it does not run on to suppuration or gangrene ; to restrict it also in extent, so that it does not involve more than the immediate neighbourhood of the injured surface.

Among cases in which the power of attaining these results has more than common importance, may be instanced the wounds of large joints, whether made by accidental incision, or designed for the removal of synovial concretions. Under an effective use of cold (together, of course, with absolute immobilisation of the limb) many a knee-joint recovers without permanent injury from even some considerable incision.

The antiphlogistic use of cold is often turned to good account, not curatively indeed, but retardatively, in cases (if not too far advanced) of strangulated hernia. A first taxis has been unsuccessful ; the sac and bowel are beginning to inflame and becoming too sensitive for manipulation ; a second surgeon is sent for to operate. Application of cold during the hour or two which may elapse before his coming, will not only prevent the development of symptoms, but often effect their temporary reduction to a point at which the taxis may properly be tried again before the knife is had recourse to.

Though it be the fact (as above stated) that in many internal inflammations the local use of cold is mechanically difficult or impossible, yet there are others to which it is applied with success. In the great hospitals of Vienna and Prague, the ordinary treatment of peritonitis is treatment by local cold ; and it is said by those who have witnessed the practice, that the results are of the most satisfactory description.

Local cooling for common antiphlogistic purposes is best effected by water of the desired temperature. Cloths wetted with it are spread over the surface which is to be acted on. It is essential to the result, that these cloths should be kept as nearly as possible at their original low temperature, either by being continuously dripped upon from a reservoir of cold water, or by being very frequently changed or re-wetted by hand. Their surface meanwhile should be freely exposed to the air, or, if necessarily within bed, should have ample space for evaporation secured to it; and arrangements should be made to prevent needless and uncomfortable soaking of the patient's bed and clothing.

As regards the temperature of water to be employed, it may range, according to the exigencies of the case, from that which the average healthy hand feels to be decidedly cold—say about 45° F., to the lowest above congelation. And the maintenance of this temperature in a bed-side reservoir of water can be regulated by ice or freezing mixture.

Every application which the inflamed part recognises as cold is, according to its degree, antiphlogistic; but, except in cases where very rapid action is required, the efficiency of the application depends less on extreme degrees of cold than on the continuous and uniform operation of even a moderately reducing temperature. Failing the continuous action of cold, cold is worse than useless. And the too frequent slovenly nursing which lets water-cloths remain for hours unwetted, or swaddles them up under other coverings, is fatal to this method of treatment. The surgeon who wishes to see what can really be effected by the continuous application of cold, must either bestow a little mechanical ingenuity on the construction of a self-acting irrigator for his patient, or must secure such scrupulous attendance at the bed-side as to render interruptions impossible.

Bladders of pounded ice are sometimes employed, instead of wetted cloths, for the purpose of local refrigeration; but the cold thus produced is greater than commonly speaking is necessary, and greater than can for long periods be continued. Perhaps the best use which can be made of ice is, in certain cases of intense onset of inflammation, to make a first local impression which minor degrees of cold will afterwards maintain.

Both as regards a first decision to use cold in the treatment of a particular case of inflammation, and as regards the time when it becomes desirable to discontinue this employment of cold, the surgeon may wisely consult the sensations of his patient. While cold gives comfort, it almost certainly does good; while it gives discomfort, it almost certainly does harm.

2. Whether, besides cold, there be other agents which act as direct depressants of textural change, and which may on this principle be used as antagonists to the causes of inflammation, is hitherto very imperfectly known. But it seems probable that the antiphlogistic

action of OPIUM (and possibly of other narcotics) is somewhat of the same kind; and the present may therefore be a convenient opportunity for referring to it. With opium, as with cold, our best chance of doing good is where we can adopt the treatment almost as soon as a cause of inflammation begins to operate; where, for instance, after some wound, accidental or operative, we can at once bring our patient under the influence of opium, and keep him, as long as necessary, more or less narcotised by renewed doses of the drug. This method of proceeding is often of signal advantage where the peritoneum has been injured; it commonly constitutes the main feature of after-treatment in cases where ovarian tumors are removed or cæsarian sections performed, and is often of the utmost benefit after operations for hernia. Its utility under these circumstances is no doubt partly due to its indirect influence in preventing such muscular movement as might displace or irritate the injured parts; for the soporised patient does not care to move from one fixed position, nor do his bowels care to be performing their peristaltic movements. But it seems probable that the same tranquillising power affects the injured texture itself—renders it, so to speak, less percipient or more tolerant of injury than it otherwise would have been, less disposed to undergo diffuse excitement, less apt to provoke hyperæmial changes in its circulation.

There are other uses of opium only inferior to that which has been named. Where inflammation has received a considerable check by depletive treatment, and further measures of the same kind are inadmissible, opium often prevents the textural excitement from rekindling. Where (as is particularly apt to be the case with persons whose constitutions are damaged by irregular and exhaustive modes of life) inflammation is attended rather by nervous irritability than by true feverishness and vascular tension, here especially if the inflammation be ulcerative or gangrenous, opium, either alone, or in aid of any specific drug which an existing specific cachexia requires, may be of indispensable value.

(*b*) The practice of treating certain inflammations by COUNTER-IRRITANT and other DERIVATIVE measures is believed to represent the application of a pathological principle. Different parts of the body naturally exercise a sort of competition with each other in their several claims on the blood,—one part necessarily tending to receive less in proportion as other parts receive more. Undoubtedly to a certain extent this rivalry is exercised through the medium of the general circulation: and thus it is that any great determination of blood to the skin may diminish supply to the kidneys. But besides this antagonism effected through the general circulation, there probably are antagonisms of a local character; and parts which are respectively supplied by different contiguously-rising branches of one arterial trunk seem specially able thus to antagonise each other. For, assuming the flow through an arterial trunk to remain the same, one branch or set of branches can only transmit more blood, if simultaneously another branch or set of branches transmit less; and we may well conceive it to be an important function of vasi-motor nerves, to provide for the adjustment of this antagonism, by establishing such inter-arterial sympathies that the relative opening of one branch shall determine the relative closure of another. As the claim of each part to receive less or more blood is measured by the degree in which it is indolent or active, so to stimulate a part is the sure way of determining blood to it. *Ubi stimulus, illuc affluxus.* And thus (it is believed) by artificially irritating one part, we may divert blood from another. The irritated part, attracting blood to itself through arteries which open wider to facilitate the process, is supposed to become increasedly antagonistic to all parts which are in arterial sympathy with it,—including, of course, any inflamed part which is thus circumstanced; and in proportion as it succeeds in diverting blood to itself, the arteries of these latter parts are supposed to become (relatively speaking) constricted, and the parts themselves to be relieved from pressure of blood.

Here, then, apparently is one considerable channel of influence for counter-irritant applications:—that through inter-arterial sympathies (which vasi-motor nerves maintain, or contribute to maintain) and in some cases through the general circulation, they tend to divert blood from flowing into the inflamed part. And, so far as the local process depends upon vascular fulness, counter-irritant treatment may, under certain qualifications, be expected, on this principle, to reduce it.

But counter-irritants may have a value beyond this; for probably it is not only as joint competitors for blood that our several bodily parts influence one another's life. Textural excitability perhaps is not so exclusively local, but that in this respect also there may be conditions of inter-textural balance: the total excitability of the body at any given moment being perhaps of fixed amount,—so that, with regard to excitement, just as with regard to blood-supply, *plus* in one organ may imply *minus* in another. Possibly too (though in the present state of knowledge it would seem not probably) the nerves during counter-irritation may operate in other ways than through arterial contractility to modify the vital actions of parts which counter-irritation is intended to relieve. These possibilities deserve to be borne in mind; lest, relying too exclusively on the derivative element in counter-irritation, we should unduly ignore methods of treatment which seem to require other principles for their explanation.

1. Surgical appliances of the class under consideration are of three grades of intensity. The *most intense* is illustrated when by caustic potash, or hot iron, or burning moxa, we make a slough of skin; or when, by running a seton under some inches of integument, we establish a track of subcutaneous suppuration;—as is often done (and now chiefly in the form of caustic issue) in the neighbourhood of joints or of the spine, where cancellous bone-structure is chronicly inflamed and carious. A *second* grade is illustrated by the various agents which cause vesication or, if they be more sparingly used, desquamation of the skin;—as when we apply various preparations of cantharides, iodine, or mustard, to the integument of the chest with the object of relieving some pulmonary or cardiac inflammation. A *third* is illustrated (where perhaps the illustration is not always looked for) in the action of common poultices;—as when, on account of a whitlow, we envelop the whole hand and wrist in poultice, and thus solicit from the radial and ulnar arteries into collateral circulation a share of the blood which before was being so partially distributed, that every beat of the heart was felt as a throb in the finger.

The more intense forms of counter-irritant treatment are so painful, that it is well worth while to be critical as to their value. And it deserves more general notice than it has yet received, that some of the most accurate clinical observers of the day are profoundly sceptical on this subject. In various cases of thoracic inflammation, for instance, where thousands of practitioners employ blistering as a matter of course, the unsurpassed authority of Professor Skoda pronounces such treatment to be always powerless for good, though sometimes powerful for harm. And probably a large proportion of treatment by long-continued setons and issues has subsisted, less from any sure knowledge of its doing good, than as a remnant of the old belief that morbid humours could thus be set running from the body. Assuredly the whole subject requires careful clinical reconsideration; towards which, in this place, only two suggestions are offered.

In the first place, particularly with regard to the uses of blistering, there is a source of fallacy against which the student will do well to guard himself. Not every cutaneous inflammation, excited for surgical purposes, is intended to be counter-irritant and derivative. There are cases (presently to be again adverted to) where it acts simply as a further stimulant to the part originally inflamed. When, for instance, we apply strong blistering fluid directly over a knee-joint with chronic inflammatory effusion, the action of the irritant propagates itself, in lessening degrees, through the intervening small thickness of parts, and sensibly affects the synovial surface; where frequently at first it causes some increase of effusion; and where at any rate the desired removal of fluid only begins when the super-induced excitement has begun to subside. And it is by reason of this action that, with regard to superficial parts, blistering, if it does not resolve their inflammation, commonly determines them to suppurate;—a fact, sometimes illustrated in the treatment of indolent inguinal buboes; where it may happen that blistering is deliberately used in order to force this alternative on the part, and, either by one way or the other, to bring the inflammation to a close.

In the second place, it deserves full trial, whether every intense and consequently painful form of counter-irritation might not be superseded by the employment of other means, less intense, but more extensively applied;—whether, for instance, ten inches of poultice may not be equivalent to four inches of blister, or to one inch of issue. For probably among the agencies now spoken of, there is none to which we can look with better-grounded confidence than to the diffuse local action of warmth, as supplied by poultices and fomentations; particularly when it can be so administered, as to affect a surface of skin very greatly larger than the quantity of inflamed texture which we desire to relieve.

In many chronic—probably also in some acute, inflammations, especially in those which arise from catching cold, and in those which are associated with gout and chronic rheumatism, the excitement of the entire skin by baths of hot air or hot vapour is often of the most striking and immediate benefit. And though in most of these cases the result of the exterior heat is probably something more than mere blood-derivation to the skin, yet not the less on that account are they important illustrations of counter-stimulant treatment.

Pending the better settlement of what is doubtful in the present subject, there are cautions which every one admits to be necessary if the counter-irritant treatment of inflammation is to succeed according to its intention. In proportion, namely, as the counter-irritants which we employ are of severe local action, we must take care,—first, that they be not so applied as to involve the inflamed part in their direct irritant operation;* and secondly, that they be not so applied as to aggravate any existing febrile disturbance.

2. It remains to be stated that there are derivatives which are not counter-stimulant. The abstraction of a very few ounces of blood from the vicinity of an inflamed part often gives relief which apparently is quite out of proportion to any effect produced on the general circulation. And there seems no way of accounting for this result, unless the action be regarded (on the principles already suggested) as a derivation of blood effected through inter-arterial sympathy.

Local blood-letting is effected by leeches or cupping:† of which methods, each has its advantages;—leeches, that they are commonly less formidable, and admit of being more universally applied; cupping, that, if the abstraction of blood is to be large, its quantity can thus be more exactly regulated. It is also believed that cupping exerts its influence through a greater thickness of tissue; and that, if we wish, for instance, to affect the kidneys, we can better attain our object by cupping than by leeching the loins. Small local abstractions of blood are proper for innumerable cases in which general blood-letting (as requiring to be much more copious in order to produce the same local result) would be wrong or even dangerous. And in cases where general blood-letting is had recourse to, sometimes local blood-letting is thought desirable as an adjunct.

The objects of local blood-letting seem to be fully accomplished by taking blood from the *neighbourhood* of an inflamed part. Indeed where it is possible to apply leeches directly to an inflamed texture, the results are not always as satisfactory as where some uninflamed texture intervenes. It seems very questionable whether inflammation of lymphatic glands is ever benefited by leeching; indeed in some cases the evil is undoubtedly thus aggravated. In cases of chronic inflammation, less advantage is got by applying, at once and for all, any given large number of leeches, than by applying fewer leeches several times in succession at intervals of two or three days; a method, which (in aid of other necessary treatment) often seems particularly useful with chronic inflammations of the breast and testicle.

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* Dr. Greenhow informs the writer that it happened to him once, in making the post-mortem examination of a patient to whose abdomen a blister had been applied, to find on the inner surface of the abdominal wall *a red patch* (probably of more injected muscular substance seen through the peritoneum) corresponding to the area of blistered skin.

† The practice of opening a branch of the temporal artery, with a view to relieve inflammations of the eye, has probably now fallen into deserved disuse.

Finally, in reference to the subject-matter of the present section, dry-cupping ought to be mentioned. By this procedure, and others which resemble it, we can effect temporary derivations of blood, without at the same time depleting or counter-irritating our patient. And there may be cases for which this unmixed derivatory treatment is more suitable than local bleeding or blistering.

(*c*) Depletory treatment includes the oldest and many of the most familiar antiphlogistic measures,—blood-letting, purging, vomiting, and starving.

1. *Blood-letting*, almost beyond any curative agent, has had strange vicissitudes of repute :—sometimes judged to be the one cure for inflammation; sometimes regarded as the deadliest aggravator of what is dangerous in the disease. Reasonable observers of this discord have believed that it must be more apparent than real,—that the inflammation, spoken of at one time as cured by bleeding, cannot but be different from the inflammation, spoken of at another time as rendered fatal by bleeding. And especially Dr. Watson (always as candid towards the opinions of others, as he is enlightened and thoughtful in his own) has strongly stated his belief that " there are waves of time through which the sthenic and asthenic characters of disease prevail in succession." Probably this is the fact. But also it is certain that differences of opinion as to the good or harm of bleeding in inflammation have not, by any means exclusively, been differences between one time and another :—contemporaries, living under the same sky, and practising in the same year on the same disease, have waged controversy on the subject; and not infrequently it has seemed probable that medical juries, inquesting any given dead patient, would divide in equal numbers whether much bleeding or little bleeding had killed the man.

" Neither to exclude bleeding, nor to bleed in excess of the present necessity; so to bleed as to secure the advantages of the remedy and to avoid its disadvantages," here, says Dr. Watson, is "the accredited practice and the precept of all teachers." To estimate that " present necessity" is the art of the skilled practitioner, treating each case according to its own particular claims ;—an art which cannot be learnt except at the bedside of the sick, and towards which, in the present place, only some general suggestions can be offered.

It is scarcely needful to say that local nutritive changes are powerfully affected by loss of blood from the general circulation. Occasionally it happens, during some process of repair, that a large accidental hæmorrhage occurs, — as, for instance, from a stump which, having at first been sloughy, has cleansed itself and is healing by granulation at the time when its main artery gives way; and in any such case we are able to observe how thoroughly the local action is arrested, how the granulations shrink, and how for some days (if the patient survive) the stump looks almost as though it did not belong to a living body. But because this kind of depletion can so suddenly stop the actions of repair, it does not therefore follow that it can with equal facility stop all that we wish to stop in any given inflammatory process; or that blood-letting is an antiphlogistic in that unconditional sense which is implied in some arguments respecting it.* The notion that, "if we could completely command the supply of blood to a part, the increased action might be effectually controlled or arrested," can never be made the basis of treatment, and even in speculation cannot be admitted without reserve. The prudent practitioner will incline to remember John Hunter's terse statement of the meaning of all local determinations of blood,—"Action creates the necessity for support, and supplies it;" and regarding inflammatory hyperæmia as but the symptom and legitimate consequence of an existing textural excitement, he will doubt as to the expediency of striking with much abruptness at the continuity of this natural dependence. For if the entire circulatory system could gradually be drained of its contents, would not the inflamed part of the body be the last of all to become bloodless? would it not to the last remain relatively congested? would it not be more prone than other parts to fall into gangrene from anæmia?

Practically, all impartial observers seem now to agree that while on the one hand there are inflammations which bleeding can relieve, yet on the other hand there are inflammations which every act of depletion, instead of diminishing, will increase. And the obvious inference from this fact is one which certainly pathology would sanction,—that the therapeutical value of blood-letting does not so much consist in its directly controlling inflammatory excitement, as in its controlling some condition which may or may not be concomitant.

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* "Blood is the material by which the increased action of the part is maintained. In the figurative language, which the obviously increased heat has suggested, we may say that it is the fuel by which the fire is kept up. If we could completely command the supply of blood, the increased action might be effectually controlled or arrested." Lawrence on *Diseases of the Eye*, 1844, p. 182.

The condition which in this point of view deserves especial notice is that state of the circulatory system which (often spoken of by the name of "vascular tension") is characterised by a hard pulse. It has already been suggested, as part of the arrangement by which an inflamed part is able to attract so much blood to itself, that, in proportion as arteries going to the focus of inflammation dilate themselves, collateral arteries become more or less constricted. When inflammation of any magnitude occurs in strong and otherwise healthy subjects, this sympathetic phenomenon diffuses itself widely over the body; the arteries generally (in contrast with those of the inflamed part) getting, by contraction of their circular fibres, into a more or less rigid state of reduced calibre,—a state, during which the heart's action (being of not less than normal force) gives to the arterial pulse its morbid quality of hardness. This quality of hardness in the general arterial pulse is therefore, according to its different degrees, a standard for estimating the pressure which an inflamed part sustains from the heart's action, and the extent to which that pressure may be aggravating the local disorder. Further, it is a symptom which is directly controlled by bleeding, and which probably never has considerable development except in cases where bleeding can be borne without injury. Generally speaking, then, it seems that any inflammation accompanied by hardness of pulse is likely to be relieved by the abstraction of so much blood as shall remove this sign of vascular tension; that bleeding (or some equivalent measure) becomes necessary in proportion as such an inflammation affects important organs or causes urgent distress;* and that, employed on these principles (as distinguished from that of attempting to anæmiate the inflamed part) blood-letting is an important resource in the treatment of severe inflammations.

Always before having recourse to bleeding, we must remember that its effects will be more than momentary. Blood cannot renew itself off-hand; and, during its paucity, all actions of repair are enfeebled. Therefore, in proportion as the patient's illness is likely to be protracted and exhaustive, the surgeon will be chary of bleeding for any inflammation which he can affect by less long-acting remedies. Especially he will hesitate to bleed for inflammations which depend on dyscrasial states, and, above all, for those which depend on the infection of morbid poisons. Nor of course will he lightly bleed for inflammations, even though severe, if they be of comparatively unimportant organs. Moreover, it is not conceivable that bleeding can ever be wanted where ulceration or gangrene is in progress. And the delirium of inflammatory fever is in itself no reason for bleeding.

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* The peculiarities of the pulmonary circulation render the lung, when its substance is inflamed, more apt than other organs to be embarrassed by fulness of the circulation; and in cases of traumatic pleuro-pneumonia, a given amount of hardness of pulse may be rendered much more significant by the presence of considerable dyspnœa.

2. *Purgatives* are in this country very largely (perhaps somewhat extravagantly) used in the treatment of surgical inflammations. Proportionately to the fluid discharges occasioned by them, they act, like blood-letting, in relief of vascular tension; and often, perhaps, all the more so, because, besides reducing the volume of the circulation, they may act (for instance, with regard to encephalitis) in a somewhat counter-irritant and derivative way. But this is not the total of their antiphlogistic action. For, since the purged bowels discharge albumen as well as water, the blood is to some extent impoverished by purging. And further, since the intestinal surface is a great emunctory for some effete matters, purging (as will presently again be mentioned) has an important place among febrifuge remedies. It is not at present possible to assign a relative value to these different elements in the antiphlogistic action of purgative medicines; but provisionally we know that purging, in its compound influence, is effective against many inflammations. A sufficient dose of some mercurial, followed after six hours or more by sulphate of magnesia or senna or both of them, is a convenient way of getting an antiphlogistic result. And in cases where almost continuous bowel-action is desirable (as, for instance, often in cases of encephalitis after injury) this kind of proceeding may be repeated on many successive or alternate days. In the few instances where sudden drastic purging is desired, croton oil (which needs not exclude mercury) may be had recourse to. And there are other cases, though probably not where purging is meant for a depletive remedy, where the patient requires more cordial treatment, and the compound tincture of rhubarb is eligible.

3. With respect to *starvation* as a part of depletive treatment but little needs be said. Active depletion, on the one hand, and supply of nourishment, on the other, are influences in mutual opposition:—in proportion as depletive measures are thought necessary, food must for the time be thought superfluous. And thus in all grave cases of inflammation the patient instinctively settles the thing for himself: incapable of taking a morsel of food, at any time when he

is properly being bled; and, at the utmost, not capable of hunger at any time when he is properly being depleted by purging. Therefore in this respect the surgeon has little more to do, than to warn the patient's friends against injudiciously pressing him to take food. In cases where the fullest effects of depletion are desired, there is no reason why the patient's drink should exceed the innutritiveness of pure water.

4. The antiphlogistic action of certain *emetic and nauseant drugs* appears in part very much to resemble the action of blood-letting. Under the action of full doses of antimony,* for instance, the pulse, till vomiting occurs, becomes progressively quicker and feebler, till sometimes it is scarcely perceptible; it then almost instantly changes its character, becoming fuller and much less rapid, but retaining a marked quality of softness; and during this state, in which any pre-existing vascular tension is for the time effectually removed, there is greatly increased action of the skin, increased secretion of urine, and increased discharge from the bowels. If the inflammation which we are dealing with is one on a very small scale but with very marked painfulness (as, for instance, that which occasions common ear-ache) we find that it is now, perhaps permanently, relieved;—that in the great vascular relaxation which has taken place, the little local hyperæmia has ceased to exist. And in more considerable inflammations, the relief, if less complete, is often not less striking. Moreover by renewed small doses of the drug (which now probably will not produce vomiting) the relaxed state of the arterial system can be maintained, and inflamed parts can thus be continuously kept with all the advantages of lessened vascular tension. Besides these advantages, relative to the distribution of blood, there probably are other ways in which antimony serves to reduce acute inflammation: and some of these will hereafter be referred to. The student, who wishes fully to appreciate what can be done by this method of treatment, should observe it in medical as well as in surgical cases; and perhaps especially he should observe it in cases of pneumonia, since it was here that fifty years ago the Italian *contro-stimolanti* first established its great antiphlogistic virtues. But many ordinary surgical cases will suffice to show him its power;—severe cases of acute orchitis, for instance, where the symptoms commonly yield with great rapidity to moderate antimonial treatment.

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* Comp. Ackermann, quoted by Clarus, op. infra cit.

From the preceding remarks, it may be inferred that antimony, like bleeding, is distinctively applicable to such inflammations as are acute, commencing, accompanied with vascular tension, and occurring in unenfeebled subjects.

Some of the properties of antimony are equally possessed by ipecacuan, and at the onset of many inflammations, especially when we are dealing with children, an emetic of ipecacuan is often a very convenient way of making a general impression on the vascular system. But as regards any ulterior use of the drug, there is no evidence that ipecacuan possesses the antiphlogistic powers of antimony; while on the other hand it has this disadvantage, that after-doses are less easily borne without producing renewed vomiting.

(*d*) Although inflammatory fever be but a symptom and consequence of the local disease, it does not therefore follow that the blood is entirely passive in the process. For the blood, not less than the tissues, contains declining material; and we may well conceive it to be the case that this material or some part of it gets infected by the inflaming tissue, or gets thrown into change by the greater heat of its menstruum, and, if so, contributes, both in respect of temperature and in respect of excretable products, to the signs of general febrility. If this be the case, the inflammatory fever would be capable of re-acting injuriously on the inflamed part, and would on this account require treatment. But, even if it be not the case, there are other reasonable grounds for believing that FEBRIFUGE TREATMENT may be serviceable; since probably the circulating blood, in proportion as its febrile temperature is reduced and its effete ingredients are eliminated, becomes more and more capable of contributing (by equalisation of effect) to reduce the local heat and to absorb the waste-products of inflammation.

As regards our known means of febrifuge treatment, it must first be noticed that all *depletive measures* tend to reduce the temperature of the blood. During inanition, there is a progressive lowering of temperature; and it is by means of this cooling (as Chossat's classical experiments have shown) that starvation at last produces unconsciousness and death. Marshall Hall's researches on the effects of blood-letting have shown that, during slow anæmiation of the body, there is the same decline of temperature.

1. To some extent the temperature of the blood can be reduced by other than depletive treatment. *Digitalis*, for instance, under many conditions of disease, will, by lowering the pulse, reduce the

heat of the body; but it seems certain* that where active inflammation exists, the pulse-retarding action of digitalis is by no means easily or uniformly obtained; and the use of the drug in large doses requires so much watchfulness, that, under this limitation, little recourse can be had to it.

2. Effectually and universally the temperature of the blood can be reduced by exposing the surface of the body to *cold air or cold water*. The former influence is made useful in cases of febrility, when we order the sick-room to be kept cool, and the patient (unless we are treating him with diaphoretics) to be but slightly covered with clothing. The latter influence is available in the form of baths or affusions; respecting the febrifuge value of which in surgical practice, it is hitherto, from the absence of sufficient data, not possible to speak with confidence. It is of course evident that, with many surgical fevers, there would be local conditions which might render it practically impossible (even if, on other grounds, it were desirable) to immerse the patient in a bath, or to affuse his entire body with water. But the student, while mindful of this probable restriction in respect of surgical cases, ought to be informed of the very decided febrifuge powers which, abstractedly speaking, belong to the method of treatment. Especially it deserves notice that prolonged immersion in what commonly would be called warm water —even as warm as 95° F., may be made the means of reducing febrile temperature.†

3. A remaining important object of febrifuge treatment is, as far as possible, to promote the due excretion of those waste-products which in part probably arise within the febrile blood, and in part accrue to it from the disorganising processes of inflammation. The tendency of these products, as they become eliminable, is chiefly to

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* See Clarus's *Heilmittellehre*, edit. 1860, pp. 597, 603. And compare Spielmann, *des Modifications de la Temperature animale dans les Maladies fébriles aigues et chroniques;* Strasburg, 1856.

† This is well shown in one of the cases which Dr. Armitage (in his instructive little volume on *Hydropathy in Acute Disease*) describes as having been treated by him and Professor Traube in the Charité Hospital of Berlin. A female typhus-patient, having a temperature of 105° F., being put into a bath at 95° F., and kept in it for fifty-seven minutes, lost during this time nearly 2° F. of temperature. So many writings on the present subject have come from inexpert persons and quacks, that it is satisfactory to be able to refer to Dr. Armitage's observations as those of an accomplished and accurate physician. The wet-sheet packing of the German water-curers, in the form in which they recommend it during febrile conditions of the system, appears to act as a cool bath.

the intestinal canal and to the kidneys, and their final discharge from the body can be assisted in the one direction by *laxative medicines* (which need not be of the more depletive kind) and in the other direction by *diluent drinks.* That more latent part of the eliminative process which is prior to the act of excretion can also, it appears, be aided by treatment:—*water*, which the febrile patient so thirsts for, is itself an effectual mover of those chemical changes which eventuate in excretion; and *alkalies*, which from time immemorial have enjoyed a febrifuge reputation, are, in the same respect, perhaps the most useful adjuncts which the pharmacopœia can supply. The *ad libitum* allowance of soda-water or potash-water is a method of treatment which the febrile patient commonly finds in the highest degree agreeable, and which probably does as much as can usefully be done to facilitate the chemical clearing of his blood In some cases of inflammatory fever—perhaps especially in cases of erysipelas, it seems that ammonia has particular advantages, as it is said* also to have in the treatment of eruptive fevers. It may be given either alone or together with the fixed alkalies.

Both mercury and antimony belong to the class of medicines which simultaneously increase several discharges from the body, and which (it is hence presumed) promote declensive change in the blood and tissues. They too, in small repeated doses, are often used to fulfil a mere febrifuge intention; but unless there be special reasons for employing drugs which also are depletive and depressant, they probably, for the present purpose, are not preferable to alkalies.

(*e*) The cases are but few, where an inflamed part, not containing pus or sloughs, is *cut into for the mere relief of vascular tension.* In case of severe purulent ophthalmia, it used to be deemed good to incise the swollen conjunctiva;† and in some cases of throat-inflammation, it was advised to scarify the surface of the tonsils and soft palate; but these expedients are of very doubtful advantage. If inflammation of the skin and subcutaneous texture be diffusing itself widely and rapidly from a first focus of intenser action, where still the inflammation runs high,—here, even though as yet there be no pus or slough, a free incision of the most inflamed part often seems to relieve the remainder, and perhaps sometimes averts what otherwise would be a considerable destruction of tissue.

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* See Mr. Witt's very interesting pamphlet on the *Use of Ammonia in Scarlet-fever.*

† See Tyrrell on the *Treatment of Acute Purulent Ophthalmia; Med.-Chir. Transact.* vol. xxi.

Pressure, which often has been recommended, and often very injuriously tried in the treatment of sundry acute inflammations, is probably now used only in one such case,—namely, in that of orchitis; where perhaps it may be, that the quantity of serous effusion which the tunica vaginalis contains renders surgical pressure more tolerable, because more uniform, than we can elsewhere render it. In common cases of gonorrhœal orchitis, a patient who cannot or will not keep his bed may move about with comparative impunity (especially when a first good impression has been made by other treatment) if the swelling be firmly and quite evenly compressed by an application of adhesive strapping. In chronic inflammations, treatment by pressure is more extensively applicable:—not only in those where (as in chronic ulcers of the lower extremity) it antagonises the mechanical causes of the complaint; but likewise in others (such as chronic inflammation of lymph-glands, and most especially chronic inflammation of the breast) in which the disease is not mechanically caused. In the latter class of cases, pressure exerts considerable influence in procuring the removal of morbid tumefaction; an influence which doubtless is not exclusively due to its power of relieving the blood-vessels.

(*f*) There are certain cases of inflammation,—cases which at present do not admit of being well explained, where, irrespectively of any known cause, the process goes on by a sort of local habit, as though the morbid action of to-day were a cause for the morbid action of to-morrow. And, with reference to many of such cases, we practically know that *to interrupt the process* is to cure it. The slight chronic inflammation which occasions ordinary hydrocele of the tunica vaginalis is without known cause, and resists common measures of treatment; the sac may be tapped a hundred times, and a hundred times it will fill again; but, let the tapping on any occasion be combined with such an injection of iodine as shall cause an access of acute (non-suppurative) inflammation, and it will be found, on the subsidence of this attack, that the hydrocele is permanently cured. In analogous affections of synovial membranes, the same principle of treatment is successfully acted on; and even more strikingly in some cases of irritable ulceration, we find the great advantage of thus "*changing the action of the part.*" Years ago, when beginning surgical practice, the writer saw this fact illustrated in a way which many times since it has been useful to him to remember:—A young man, of generally weak health, had one side of his neck affected with very painful ulceration, not deep, but extensive, and irregularly spreading; during some months all sorts of tonic and contra-scrofulous treatment had been unsuccessfully tried, and latterly, on account of the patient's continued suffering and broken rest, it had been requisite to give opium freely; when at last, after so much fruitless treatment, it occurred to the writer that perhaps caustic might do good, and the whole large irregularly ulcerated area was in consequence carefully sponged over with a strong solution of nitrate of silver; from which moment (so soon as the smart of the operation had passed away) no more pain was experienced, ulceration was entirely at an end, and without further treatment the surface forthwith proceeded, like any common healing sore, to complete and permanent cicatrisation. If due care be taken to discriminate cases to which this principle of treatment may properly be applied, results, not less striking than that just quoted, may often be seen to follow its adoption:—for instance, the most painful paronychial ulceration may often be cured, as though with a specific, if the strong iodine-paint be once thoroughly applied to its surface.

(*g*) Where the inflamed part is the seat of a putrefactive process (as, of course, is the case wherever gangrene is present) the use of *chlorinous washes*, or—perhaps better, where practicable, the abundant application of powdered *vegetable charcoal*, is to be recommended;—and this, not only for deodorising purposes, but also with a view to reduce as far as possible the entrance of putrid matter into the patient's circulation. Where this putrid infection is occurring (and probably its occurrence in connexion with inflammation is not altogether confined to cases where there is gangrene in mass) the resulting diarrhœa seems specifically controllable by *kreosote*, internally given.

(*h*) In treating particular cases of inflammation, it often becomes of great importance to prevent those evils which may accrue, as it were secondarily from the process; evils, that is to say, which *depend on products and results of inflammation.*

1. Look, for instance, at this common case:—a patient has some, perhaps inconsiderable, lumbo-vertebral disease, which occasions an abscess to form in front of his spine; this abscess, having no ready outward way to empty itself, goes on from day to day slowly getting larger by addition to its contents, extends within the sheath of the psoas muscle on one side, or perhaps on both sides, of the body, and occupies more and more space till presently it reaches the inner side of the thigh; still restrained by fasciæ which it can only slowly tra-

verse, it grows larger and tighter within the belly, and branches in whatever direction offers least impediment to its increase; so that the patient, whose primary disease affected perhaps not a cubic inch of bone, has got, as a secondary result, an abscess reaching from loins almost to mid-thigh; and when at length this abscess bursts or is opened, there at once begins over the whole wall of its enormous cavity a greatly-excited process of suppuration, under which the patient rapidly becomes hectic, and oftener dies than recovers. There are evident anatomical reasons why, in the case described, the surgeon can do comparatively little to avert the dangerous result; but in innumerable other cases, where similar secondary mischief tends to arise, it is almost entirely under control. For, except where pus is out of reach because of important intervening viscera, an *incision* can at once render accumulation impossible; and it is one of the most imperative rules of sound surgery, never to let any properly reachable abscess enlarge for want of this simple proceeding. Especially this rule claims to be well recognised in the management of articular inflammations. For there was an old surgical superstition, that, because wounds of healthy joints are dangerous accidents, therefore abscesses of joints must be specially dangerous to open; and even now sometimes a surgeon can be found, who, with this stupid fear, will let the pus of an articular abscess increase and spread till it disorganises a limb, rather than use his knife to give it a timely escape.

2. With respect to the *removal of parts* which inflammation has killed, or rendered unpreservable, only a few general remarks are here necessary. Dead soft parts are dealt with by nature so inimitably well, that the surgeon during this natural process has, as a rule, nothing further to do, than to take precautions (already adverted to) against putrid infection, and to see that subcutaneous or deeper sloughs are not retained or made noxious by the want of sufficient outward opening. With dead bone the case is different;—for though the living bone becomes discontinuous from the dead, as completely as any living soft part from its slough, yet the bony sequestrum, sometimes held by overlying textures, sometimes locked within its capsule or cylinder of callus, almost invariably requires surgical assistance for its removal. And this assistance has to be given with due regard to two considerations;—first, that it cannot be effectual till the natural discontinuation is complete—a period which varies, from less than three weeks in the case of small superficial sequestra, to perhaps as much as three months where the entire thickness of a shaft has to divide itself across; and secondly,

that, when this period has arrived, the sequestrum (since it is a continuing cause of inflammation) ought without delay to be removed.

Also, when an inflamed extremity becomes in its whole thickness gangrenous, bone and soft parts together, surgery must in most instances be the agent of its separation; and here, even more than in the last-mentioned case, the moment for surgical interference requires to be judiciously chosen. In reference to this choice, the only general principle which can here be stated (and it is one which transfers the discussion to future pages of the present work) is, that, in order to amputate with success for gangrene resulting from inflammation, we must wait till the inflammation have ceased to be a spreading process,—wait, till nothing more of it be left than that which the gangrenous tissues maintain in their own immediate vicinity. Indeed, not only where inflammation is gangrenous, but commonly with the results of local injury or disease, in proportion as advancing inflammation and inflammatory fever are present, amputation is likely to bring worse evils than it can remove. And with every inflammation which suggests a necessity to amputate, the same principle applies as that which is recognised with inflammatory gangrenes,—to wait till nature have arrested the process, and have circumscribed its results by her own line of demarcation.

Long-continued exhaustive suppuration, and perhaps in some very few cases the mere pain and irritativeness of an intractable chronic inflammation, are other conditions which (for instance, where joints are affected) may oblige the surgeon to excise or amputate. But the rules which are appropriate to these cases, as well as the rules which relate to the treatment of parts rendered useless and inconvenient by inflammation, are of too special a kind to be considered in the present essay.

(*i*) The *pain of inflamed parts* is very often sufficiently considerable to require that *special means should be taken for its relief.* And often under such circumstances, unless in the individual case there be reasons against it, opium, or other like treatment, must be had recourse to. But before concluding that this is necessary (especially where severe pain outlasts or outmeasures the apparent intensity of an inflammation) the surgeon will carefully consider whether, instead of thus palliating the patient's pain, he cannot in other ways more effectually remove it. Some of the worst pains depend on the presence of pus;—a patient, who perhaps for years has been racked with pain in one or other end of his tibia to an extent that no narcotics could render tolerable, is instantly and permanently relieved by the trephine which lets out, it may be, not a tea-spoonful of confined pus from within the bone; and in innumerable suppurations of soft parts (breasts, joints, tonsils, lymph-glands, even cellular membrane) all which is severest in the pain depends upon the pressure of pus, and may be ended with the stroke of a bistoury. Other extreme pains have other removable causes:—the pain of simple subarticular caries, so severe while the joint is let move, becomes tolerable under the proper use of a splint; and in the frequent case where subarticular caries is kept up by the constant irritation of some small sequestrum of bone, its terrible pain will cease if this sequestrum be withdrawn. And there are other cases where some atrocious pain, together with the inflammation which it characterises, can be treated (as our next section will show) by drugs more effectual than opium.

Inflammatory pain is often relieved by the moist warmth of poultices and fomentations. The diffuse derivative action thus exerted is, no doubt, often the immediate cause of the relief. In some cases, especially in those of superficial phlegmonoid inflammation, the relaxative influence which moist warmth exerts on the contractile tissue of the skin may have more to do with the results.

Poultices and fomentations at higher degrees of temperature—indeed as hot as the patient can bear them, are used by some practitioners in order to accelerate the formation and discharge of pus. And there can be no doubt that the stimulus of heat thus applied may produce the proposed effects—may quicken the textural germination which gives pus, and may expedite the ulcerative changes which allow an abcess to empty itself. But in both respects the method of treatment is objectionable:—for, on the one hand, if pus have not formed, its formation ought, if possible, to be prevented; and, on the other hand, if pus have formed, the course is infinitely better, that at once we discharge it by incision, than that, during the slow action of poultices, we allow the abscess painfully to become perhaps many times larger than it needs have been.*

(*k*) There are kinds of inflammation which have their *specific*

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* It is a venerable practice which the writer ventures to condemn. More than two thousand years ago, Aristotle seems to have been puzzled by the therapeutics of poulticing. Why is it (he asks) that one man ripens inflammation with heat, while another man resolves it with cold? *δια τι τας αυτας φλεγμασιας οἱ μεν ψυχοντες ὑγιαζουσιν, οἱ δε θερμαινοντες πεπτουσιν*; Problemat. 45.

antidotes. The periostitis and rupial phagedæna of tertiary syphilis cease when iodide of potassium begins to act. The paroxysm of gout is relieved by colchicum. Many chronic skin-inflammations are more or less amenable to arsenic. Others are tractable by pitch. Sometimes a fibrous inflammation (perhaps especially sclero-iritis) will abruptly yield to a few doses of turpentine. Mercurial inflammation of the mouth is cured by chlorate of potash. For some chronic rheumatisms sulphur seems to be a cure. The inflammations of secondary syphilis are subdued by mercury. Occasionally, but not often, an inflammation called scrofulous will suddenly begin to go when cod-liver oil is given. To some cases of inflammation, alcoholic stimulants are a benefit; to others, the tonic influence of quinine. Malarial neuralgia (but how far this is inflammatory may be questioned) is stopped by the drugs which cure common ague. And other cases, more or less satisfactory, might be adduced to the same general effect.

It would be impossible here to discuss at any length, either the circumstances under which these several specific agencies may be employed, or the intimate nature of their respective operations on the body. As regards the former set of questions, the writer can only refer to treatises on the several specific diseases which he has named; and as regards the latter set of questions, he will only venture on one general remark. Wherever we oppose inflammation by means which, comparatively speaking, are intelligible to us, our agencies are those which depress common textural excitement:—hence in the obscurer cases now referred to, where textural excitement yields to remedies of a different description—to remedies which are non-depressant or even stimulant in their kind (as for instance, where psoriasis yields to arsenic, or iritis to Chios turpentine) it seems reasonable to infer, that the action of the remedy is not primarily on the inflammation itself, but rather on those hitherto not analysed conditions of dyscrasy or ferment wherein the inflammation has its cause.

And this argument suggests that here may be the most convenient place to mention how great an influence is exerted on some dyscrasial states by the treatment, or part of the treatment, which is popularly known as the "*water-cure.*" Much bequacked though this subject has been, the student ought to be aware that, according to the testimony of very competent observers, the water-cure is, for good or bad, an active method of treatment; which, if practised during health, causes the body to undergo considerable chemical changes; and which, if medically applied, is capable of greatly aggravating or greatly amending different morbid conditions. It is declared to be highly effective against some of the chronic and recurrent inflammations just adverted to; especially against gout and rheumatism, and against those skin-diseases and those so-called "congestions" of liver and mucous membranes which depend on the same dyscrasies, or on similar constitutional states. Reverting to what in a former section was argued with regard to the pathology of gout and some allied disorders, we cannot be surprised that certain measures of water-treatment should enjoy a reputation for curing them. For assuredly our first practical step from those pathological considerations would be, to inquire after means *whereby defective textural waste can be accelerated;* and probably such means are presented in their simplest and most manageable form in some of the appliances of the water-cure. With increased water-drinking there is increased discharge of solids in the urine:—Böcker, experimenting on himself during two successive weeks, with different allowances of water, found that while he was drinking daily about five pints of water, the solids of his urine were nearly 10 per cent more than when he drank only about two pints of water; the urea being increased by fully a twelfth part, the chlorides by nearly a third, and the sulphates and phosphates less considerably. Again with the external appliances:—Dr. Lehmann of Rolandseck says that after a cold sit-bath lasting a quarter of an hour (during which about a fifth of the entire surface of the skin is reduced as much as 12° F. in temperature) the urea and uric acid are both, for the time, greatly increased;—a result which he attributes to greater aeration of the blood, consequent on the respiration being accelerated, while the pulse is rendered less frequent; and he estimates that 67½ grains of carbon must be oxidised to repair the loss of temperature which the bath occasions. The protracted sudorific packings are said to produce a more considerable waste of tissue than any other of the measures employed. Persons who have given most attention to these methods of treatment affirm that during their action, in cases to which they are suitable, the healthy nutrition of the body is promoted, in proportion as refuse-materials are actively disengaged. They insist upon this as an essential distinction between water-treatment, and treatment by mercury or other eliminative drugs.

(*l*) Purgative preparations of mercury have already been mentioned as capable of contributing to the depletive treatment of inflammation. But other antiphlogistic merits are claimed for mercury: and, although the validity of these claims is hitherto far from being settled, there is much consent of authority in favour of at least one part of them:—viz. that the *constitutional action of mercury opposes the organising efforts of inflammation;* and that accordingly, if the drug be given in such sufficient successive quantities as to produce a certain amount of mercurial cachexia, inflammation will be prevented from leaving behind it those adhesions and false membranes which, when left, are often permanent injuries to health.

It is scarcely possible at present to speak with certainty on this alleged action of mercury. Perhaps some who defend it have too easily taken for granted, that what they see of it in syphilitic iritis (where the existing morbid poison is specifically subject to mercury) must be common to it under all circumstances. Perhaps, too, some have not sufficiently discriminated between the organising actions of inflammation, and the mere laminar concretion of fibrin,—have not sufficiently made sure, that what has seemed to be the disintegration of nascent tissue has not been mere dissolution and removal of clot. Perhaps, moreover, many who speak very confidently on the power of mercury to cause the removal of inflammatory effusions are not aware of the great efforts which unassisted nature makes for this purpose; efforts, so great and so successful, that some of the first living physicians, even in dealing with pleuritic and pericarditic effusions, trust almost entirely to this natural process, and busy themselves with little more than repairing the patient's general health.

On the other hand, in such glimmering light as pathology can throw on the subject, it does not seem unlikely that mercury may act in the manner described. That its common primary action is to prevent or unsettle some chemical combination within the body—some combination which stands in close antecedence to more than one special secretion, has been taken, almost by common consent, as the hypothesis whereby to account for its power of stimulating simultaneously many different secreting organs. And it is no great enlargement of this hypothesis to believe that the drug, with prolonged use, can extend its disintegrative action from lower to higher organic combinations,—from material which is nearest excretion to material which forms part of structure. Contemporary experience fortunately does not give us on this point such crucial experiments as were made by the salivators of fifty years back; but tradition says, that, in patients whose mercurialism was measured by the potful, granulating surfaces used often to change their action to sloughing, broken bones would be withheld from repairing themselves, and even united fractures would sometimes re-dissever their union. For these reasons one hesitates to deny that mercury can disorganise even the completest texture which adhesive inflammation leaves behind it. But it seems little likely that any fully-organised new tissue can be thus changed, except under an amount of cachexia which would equally endanger the vitality of other tissues; and there certainly is not room to suppose that mercurialism, in its common antiphlogistic use, borders thus closely on poisoning. Accordingly, if mercurial cachexia in its lesser degrees, and independently of the purging which may attend it, has a real effect on inflammatory products, this effect probably relates only to such products as are not organised, and perhaps is nothing more than the giving of some special assistance to the dissolution and removal of fibrin.

How far it is desirable, for the sake of this, or any proved or believed advantage, to have recourse to mercurialism as a part of common antiphlogistic treatment, is a practical question on which there are wide differences of opinion. The writer may confess that for many past years in his treatment of inflammation (excepting of course certain syphilitic inflammations) he has never had recourse to mercurialism. He had previously got to regard its influence as often the very reverse of febrifuge.* His utmost use of mercury in inflammation has been to give it in single purgative doses. But it would be unjust to form an estimate of the value of mercury from an exclusively surgical practice; and the following paragraphs from Dr. Watson's admirable *Lectures on the Practice of Physic*, besides showing that in this different field of practice, opinions, entitled to the highest respect, are expressed in favour of the drug, may also serve to teach on the best authority how such opinions are practically carried into effect. "Next to blood-letting, as a remedy, and of vastly superior value upon the whole, to purgation, in serious inflammations of various kinds, is mercury. This mineral is really a very powerful agent in controlling inflammation; especially acute, phlegmonous, adhesive inflammation, such as glues parts together, and spoils the texture of organs" . . . . "and if we, in our turn, could always bridle and limit the influence of mercury itself, it would be a still more valuable resource" . . . . "In common adhesive inflammation, whether of the serous or the areolar tissues, whenever, in fact, you have reason to suppose that coagulable lymph is effused, or about to be effused, and mischief is likely to result from its presence, then you may expect benefit from the proper administration of mercury; as an auxiliary, however, to blood-letting, when blood-letting is indicated,—not as a substitute for it. On the other hand, mercury is likely to be hurtful in those forms of disease where the morbid action approximates to its own action; in cases of erysipelatous inflammation having a disposition to gangrene; in scrofulous diseases, in inflammatory complaints attended with general debility, and an irritable condition of the nervous system, or a manifest tendency to take on a low and typhus-like character. When we have to contend with acute inflammation, and desire to prevent or arrest the deposition of coagulable lymph, our object is, after such bleeding as may have been proper, to bring the system as speedily as possible under the specific influence of mercury." . . . . "We know that the whole system has been brought under the specific influence of mercury, as soon as its effects become even slightly perceptible in the gums and breath of the patient; and in adults we cannot be sure of it before. The gums grow red and spongy; the patient complains that his gums are sore; and that he has a metallic taste, a taste like that of copper, in his mouth. At the same time, an unpleasant and very peculiar fœtor, easily recognised again when it has been once perceived, is smelt in his breath. These symptoms are enough; you need not in general look for any more decided affection of the mouth, such as ulceration of the gums, swelling of the glands beneath the jaw and of the tongue, and a profuse flow of saliva" . . . . "all that is requisite is that the gums should become distinctly tender, and that the mercurial fœtor should be unequivocally manifest, and that these symptoms should be kept up for a certain time. Now this is best effected, usually, by giving some form of mercury in equal and repeated doses, by the mouth. For urgent cases calomel is the best form in which it can be administered; two or three grains given every four or six hours, will generally suffice to touch the gums in the course of thirty-six or forty-eight hours. If it act as a purgative, its specific effect upon the whole system will be postponed by that circumstance; and it then becomes expedient to combine with it just so much opium as will prevent its passing off by the bowels. A quarter of a grain of opium with two grains of calomel—or a third of a grain of opium with three or four grains of calomel—will generally be sufficient to restrain the purgative operation of the latter. When a speedier effect is desirable we give larger doses; such as five or ten grains every three, or even every two hours; or we combine mercurial inunction with the exhibition of calomel by the mouth. It is impossible to lay down any precise rule that will fit all cases. Blue pill, or else the hydrargyrum-cum-creta, may, in certain cases, be preferable to calomel; but they must be given in greater quantity." . . . . "This mode of administering mercury, so as to affect the system at large, is eminently useful in many instances of acute phlegmonous inflammation, after bleeding has been carried as far as the circumstances of the case may warrant. I repeat that it must not be allowed to supersede blood-letting, when that remedy would of itself be eligible. Previous bleeding renders the body more readily susceptible of the influence of mercury; and the operation of the mercury comes in aid of the salutary effect of the abstraction of blood. The two remedies accomplish by their joint power what neither of them might be able to accomplish singly." . . . . "Mercury is of great service in many cases of chronic inflammation; and I may repeat here the observation I formerly made when speaking of blood-letting—that the treatment must keep pace, as it were, with the disease. When textures have been slowly altered by a gradual deposition of coagulable lymph, we should gain little or nothing by suddenly or speedily salivating our patient. The lymph, if it can be dispersed at all, must be gradually taken up again; and mercury, given with the view of promoting its absorption, must be slowly and gradually introduced into the system, and its specific influence, when at length it is felt, must be sustained for a considerable length of time. You must not expect any good, but the contrary, from the exhibition of mercury in scrofulous inflammations; and where the scrofulous diathesis is well marked, you should be cautious in giving mercury at any time. But I am certain that many men are too scrupulous in this respect; and that, through over-tenderness of your patient's constitution, you may risk his life, by withholding mercury because he shows tokens of scrofula. You may recollect my stating that scrofulous persons are not exempt from attacks of common inflammation; and in some such cases the possible aggravation of their general ill-health, by mercury, is not to be put in competition with the immediate danger from the local inflammation. I have again and again seen scrofulous patients benefited by moderate salivation; which, if it proved injurious at all to their general condition, was certainly less injurious than the unchecked local complaint would have been."

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* An observation made by Dr. Spielmann (op. cit. p. 22) seems, in this respect, to be of considerable interest:—"Lorsque dans le cours d'une maladie aiguë contre laquelle on a employé la mercure, il survient une stomatite mercurielle, la température subit un accroissement notable. De 39 à 40° elle est portée à 41 à 42°. Cette élévation anormale persiste aussi longtemps que la stomatite. Il faut donc se garder d'attribuer l'élévation de la température ou la recrudescence de la fièvre à une exacerbation de la maladie primitive."

The only further remarks which the writer thinks it necessary to make on the present subject, though they are founded mainly on the use of mercury in syphilis, may be of interest to persons who propose to use it in inflammations:—first, that in cases of obstinate resistance to mercurialism, the resistance will often give way, if antimony during a day or two be also administered to the patient,—a half-grain dose of tartar-emetic to begin with, and afterwards a few quarter-grain doses at eight-hour intervals:—next, that long-continued mercurialism not only does not need to be assisted by other lowering measures, but almost always requires to be combined with generous diet, and not infrequently is attended with better results, if the patient be treated simultaneously with doses of iron or quinine.

The effects of mercury on the mouth sometimes greatly exceed the intentions of the administrator; and it may therefore be convenient here to mention that for this action on the mouth, chlorate of potash appears to be an antidote. Information on this subject, derived by M. Alfred Fournier* from the practice of M. Ricord, entirely confirms the statements previously made by Herpin and others. And the writer, so far as his trials of it have gone, can speak to the same effect.

(*m*) The convalescence of a part from inflammation—the process by which, when inflammation has begun to decline, the texture regains its old conformation and reverts to its old habits of life, is one in which nature, commonly speaking, acts without solicitation from art. Subsidence of excitement having once commenced, gradually but spontaneously, the normal order of things appears again;—the ulcerated substance, so far as it admits of reparation, is repaired by a continuous process of growth; the inflammatory effusion, so far as it has not become permanent tissue, is re-absorbed; the dilated blood-vessels return to their former dimensions. And while these actions of recovery move on in their due course, the best that we can do is to refrain from interfering with them.

But sometimes the process hangs fire:—the ulcer, though no longer inflaming, yet does not actively repair itself; the granulations, though up to the skin-level, do not cover themselves with cuticle; the serous or fibrinous effusion, though free from pus, does not get removed; the mucous membrane, though scarcely over-sensitive, does not stay its defluxion; the blood-vessels, though local hyperæmia be no longer demanded by local excitement, remain of augmented calibre. And under these circumstances we may do good by interference.

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* *Leçons sur le Chancre*, professés par le Dr. Ricord, rédigées et publiées par Alfred Fournier; append. no. xii. The doses of chlorate of potash given were commonly ninety grains during the day; and it is very expressly stated, that, while the inflammation of the mouth is thus effectually cured, the therapeutical influence of the mercury is in no degree diminished.

In a large proportion of such cases, the defect of local action subsists through no fault of the part, but through some incompetency of the general system. Inordinate severity of the recent inflammation and fever, or over-vigorous depressant treatment, or previous unwholesome influences, or constitutional peculiarity, may have set the body into a state unfavourable for convalescence. The blood may be not nutritive enough for the purposes of re-construction, or the nerve-power may be too reduced for the recovery of vascular tone. And under any such circumstances, our best mode of assisting the local recovery is, *to amend the general health* in respect of whatever defect we discover there,—perhaps by more animal food, perhaps by more alcoholic stimulants, perhaps by removal to country-air, perhaps by quinine, perhaps by iron; during which treatment (particularly where the object is to recover local vascular tone) it may sometimes be desirable also, but with much caution, to use direct stimulants to the inactive part.

But sometimes it happens that local recovery is languid, in cases where the general health either has shown no defect or has apparently been relieved from any which existed. And it is especially in these cases that *local stimulating treatment* may be of essential service. Direct means for this end are very various, and of course require to be chosen with special reference to the part on which they are to act. Thus, where an ulcer or a superficial mucous membrane is concerned, we have recourse to the occasional touch of some chemical stimulant,—of nitrate of silver or sulphate of copper, for instance, either solid or in strong solution, or of iodine paint; or to the continuous application of similar substances in extremely weak solution. Where skin-covered solids are to be treated, we try the occasional employment of the cold douche, or of friction or electricity, or the continual maintenance of pressure. Where serous or synovial sacs are to be dealt with, we use such vesicants or strong irritants, as, when applied to the covering skin, will extend their stimulation to the deeper texture. And, among the cases referred to, there are some where the local treatment is often of very marked advantage; as those cases of serous and synovial dropsy, and those cases of indolent infiltration of glands, where blistering can most properly be used; and those of chronic vascular congestion for which the douche is more specially suitable.

It will be observed that some of the agencies here mentioned have already been referred to, as occasionally useful in other circumstances; namely, not when all inflammatory excitement has passed away; but even, under peculiar conditions, during a certain amount of chronic excitement, and for the immediate purpose of converting that chronic excitement into transient acute inflammation. Those objects are professedly different from the objects here under discussion; but it is not always easy to separate the two classes of cases, which here for convenience have been distinguished; nor can it confidently be said that the respective methods of treatment differ, except in degree, from each other.

It also deserves notice, that there are textures, which, if after inflammation they require to be stimulated in their actions of repair, may have specific stimulants conveyed to them through the blood. Habitually, in the treatment of pulmonary and urinary catarrhs, the affected mucous membrane is in this way stimulated by some resinous or balsamic drug taken into the stomach; and occasionally, in well-selected cases and with extreme caution, the spinal cord may be thus affected by strychnine. It scarcely needs to be said that, in every case where question arises of stimulating an important organ which has been inflamed, full regard must be had to the danger that undue local action may thus again be excited. More than ordinary care must be used, both as to the local admissibility of stimulation, and as to the particular stimulus which may most fitly be employed; and in proportion as the case is critical, the practitioner will scrupulously consider whether the desired end can be attained by means less liable to mischance.

B. CAUTIONS AS TO THE APPLICATION OF ANTIPHLOGISTIC TREATMENT.

In discussing hitherto the various means by which inflammation may be treated, the writer (in accordance with the intention of the present essay) has of necessity done so in very general terms. Also he has rather sought to show what indications those several means are capable of fulfilling, and on what principles they accordingly must be used, than pretended to arrange all possible cases of inflammation under different heads with an appropriate system of treatment for each. A more detailed exposition of the subject, and a more clinical method of considering it, have alike been thought unsuitable to the present occasion. Perhaps therefore it may be well to remind the student that general principles will be valueless to him for practical work, unless they be applied with thorough attention to detail. Practically to recognise what distinctive treatment is wanted in each individual case, and practically to estimate with what quantity of such treatment the want can sufficiently be met,—these, the hourly-recurring problems of practice, can only be solved by him who minutely studies the case which is before him, and intelligently compares it with other like and unlike cases previously also studied with minuteness. No more than the galvanic battery can produce its results without the wires which complete its circle, can the great truths of pathology and therapeutics conduce to the successful treatment of individual cases of disease, except through the medium of observant, discriminative, skilled application.

Fully to exhibit the art of this application, is the business of the clinical teacher; and his function cannot be imitated with success in any printed system of surgery. Moreover, as regards the treatment of inflammation, whatsoever is distinctive in the requirements of different organs when they are inflamed, and whatsoever is distinctive in the requirements of different varieties of inflammation, will be discussed in special succeeding articles, and are therefore no part of the present writer's subject. Accordingly he will attempt nothing further, before closing this section of his essay, than to convey some few cautions (still of a general nature, though from a more bed-side point of view than he has yet taken) as to the spirit in which antiphlogistic treatment must be applied;—not pretending to direct the student as to the circumstantial treatment of individual cases, but rather seeking to deter him from too hasty conclusions as to the facility of treating inflammation from the basis of general formulæ.

Inflammation, seen at its onset, commencing violently, exciting general vascular sympathy, and affecting some important part in a person otherwise sound and vigorous, may, in the absence of qualifying circumstances, be regarded as the type of cases for which lowering treatment is appropriate. Where the enumerated conditions are reversed, or in certain respects qualified by other conditions, such treatment ceases to be admissible.

In proportion as the patient's age, mode of life, previous or present disease, or other circumstances, render him peculiarly depress-able, general bleeding, antimony, and vigorous purging fall from our list of applicable means; giving place (even though the inflammation be acute and important) to local agencies, repressant or derivative, and to moderate febrifuge treatment.

In proportion as the inflammation is no longer commencing,—still more where it has become chronic, or has established suppuration, lowering measures are sure to be hurtful.

Where the inflammation is in its kind ulcerative or gangrenous, lowering treatment is almost absolutely contra-indicated.

Where the inflammation depends on any specific dyscrasia, lowering treatment can scarcely ever be advantageous; nor perhaps generally can it be harmless.

Where the inflammation is produced by a morbid poison, very moderate febrifuge treatment is commonly the utmost that can be adopted.

Moreover, the amount of lowering treatment which the general system can with impunity bear, is not the only measure of the vigour with which such treatment ought to be employed. There are circumstances—especially those of mechanical and chemical injury, under which a certain quantity of inflammation is quite inevitable; and where to treat the inflammation without remembering the magnitude of its cause would be a fatal error of practice. When, for instance, with a given smash of limb, we determine not to amputate, but to rely on the reparative powers of the patient, we know that the comminuted bone, the torn integuments, the pounded muscle, can only recover by passing through a series of changes which begin with acute inflammation; that to prevent inflammation (were it possible) would be only to retard repair; and that our sole business with the inflammation is to moderate whatever excess it may have beyond that which we recognise as directly accounted for by the lesion. So again, when we operate for the extraction of cataract, we do not expect that the cornea, which we have cut in half its circumference, will remain, like the cornea of a dead body, without signs of having experienced injury; we know that the line of incision, and the ministerial blood-vessels in the conjunctiva, will presently get an aspect very different from that of health; but if, with bleeding and antimony, we could cause these phenomena not to develop themselves, we should but hinder the process of healing which they essentially indicate. And, it deserves very particular notice that where, in consequence of injury, the inflammatory phenomena tend to more than ordinary local diffusion, or involve more than ordinary destruction of tissue, this excess of local irritability is not amenable to treatment of a generally depressing kind.

Further, it is important to recognise that inflammation, even of considerable activity, may co-exist with states of weakness and exhaustion which require to be treated on a system the very reverse of depressant. Often (as has been explained in discussing the causes of inflammation) defective nourishment of the body reduces various textures to a state in which, with little or no discoverable exterior cause, they begin to inflame, and continue ulcerating, sloughing or suppurating, till generous diet restore the proper richness of the blood. Practice among the poorer classes of society is constantly showing us inflammations of this kind, veiled under a great variety of names, but as essentially starvation-phenomena as were those memorable ulcers of the cornea which Magendie produced in dogs by depriving them of nitrogenous diet. And although residence in the foul atmosphere of over-crowded and ill-cleansed tenements, irritation from bodily dirt and vermin, and exposure to cold, to violence, or to infection, are influences which, in the cases referred to, may primarily or secondarily modify the starvation-phenomena, and render necessary some adjuvant measures of treatment, the indispensable condition of recovery is, that food be liberally supplied. Also during the repair of severe wounds, accidental or surgical, it often happens (even with persons of apparent health,—though commonly where there is marked feebleness of pulse) that first a stand-still of the reparative process, and then some re-ulceration of the granulated part, give evidence of a relatively insufficient diet; and that, in order to prevent the wound from converting itself into an irritable sore, we must give more food—or perhaps especially more wine, or beer, or brandy to our patient. And it is not only in obvious dependence on defective diet, or during the repair of exhaustive injuries, that we find this kind of necessity arising. For inflammation also associates itself (particularly in the form of irritable ulcer, and of sub-acute mucous catarrh) with states of depression, which especially belong to urban life, with its impure atmosphere, with its over-work and anxiety, with its absence of beautiful objects, with its dulness of physical being. As regards the textural conditions which under these circumstances develop or maintain inflammation, nothing definite is known; but it may well be, that they are in close affinity to those of defective nutrition; and practically we see that the inflammation yields to tonic and stimulant treatment. Quinine is here often of very marked advantage.

It has already been said that the inflammations which are symptomatic of morbid poisons scarcely ever require more than the most moderate antiphlogistic treatment. Often they do not require more than the gentlest local treatment of this description; and in a large proportion of instances they require (or, more correctly speaking, the general state of the patient requires) that stimulants should be more or less liberally given. Not to dwell on such inflammations as lie outside the limit of surgical practice—such inflammations as those which occur in scarlatina, in typhoid fever, and in typhus, we may here more properly refer to the facts of erysipelas; in which disease it scarcely ever happens, but that from an early period we are aware of imperfect vigour, often of considerable debility, sometimes of alarming exhaustion, in our patient; whose stomach, moreover, is commonly intolerant of solid food; and whose chance of living through the inevitable duration of his fever is then altogether dependent on the use of alcoholic stimulants. The very dangerous infection which is produced by inoculation with some cadaveric matters (apparently with inflammatory products at early periods after death) has close affinity to erysipelas; and a careful perusal of the published fatal cases of this disease leads the reader to suspect, that an injudicious employment of depressing treatment must often greatly have conduced to render recovery impossible.* The subacute inflammations which arise from constitutional syphilis (especially those which lead to ulceration) invariably become worse under lowering treatment; and where mercurial courses are employed in dealing with these inflammations, it becomes of paramount importance that the patient should have a generous diet, and sometimes that he should further be protected by the concurrent use of quinine or of iron.

Between cases which urgently require lowering treatment, and cases which urgently require tonic and stimulant treatment, there are of course innumerable gradations. And the student must not suppose that the one line of treatment is the necessary alternative to the other. We may not bleed, or antimonialise our patient, and yet not give him brandy or quinine. In an immense majority of cases, neither course is necessary; the inflammation not justifying the first, nor concurrent debility the second; so that, as regards these alternatives, nature may be left to her own unassisted working.

Here, as everywhere else, over-doctoring is an evil. Strong measures are not for trifling purposes; nor ought treatment at all to be used, except where treatment is necessary. In medicine, as in ordinary life, it is the great test of common sense that a man seeks —and it is the great reward of observant experience that he learns, to make his *means proportionate to his ends.* The over-doing of treatment, in comparison with the results which are to be attained, is an evil especially to be guarded against by those who begin therapeutics as an application of general principles; and it is therefore here particularly adverted to.

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* See the late Mr. Travers's *Inquiry concerning Constitutional Irritation.*

Moderation, it needs hardly be said, is all the more necessary in cases where possibly the line of treatment may be wrongly chosen.

Most of all, before proceeding to the adoption of measures which depress the general health, the surgeon should have a very definite notion of the object which he means to accomplish, and should be sure that this object (if he can attain it) is worth the sacrifice. Even for the certainty of conquering some relatively unimportant local ailment, he would not hastily resolve to submit the sufferer to months of painful, or enfeebling treatment. Still less will he be disposed to try such an experiment, even with his patient's sight or hearing at stake, when he knows (as, in respect of chronic inflammation and results of inflammation, he well may know) that almost inevitably it will be a failure.* And as the case becomes more important to life, more and more he will remember that lowering treatment, if unnecessary, is dangerous. For every inflammatory fever, in proportion to its intensity and duration, is necessarily followed by exhaustion; and every inflammation, in proportion to its magnitude, depends on vital power for convalescence; and he who without reference to these facts, needlessly depletes and lowers his patient even during the height of inflammation—much more, he who does so during secondary conditions of the disease, will often contribute to render exhaustion deadly, or textural repair impossible.

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* The records of special surgery—perhaps especially of ophthalmic, aural and venereal surgery, could contribute illustrations of this doctrine. Too often it has occurred that a practitioner, over-zealous for what he calls "decided treatment," and overlooking the plain facts of the case before him, has been undeterred by sickly constitution, by pallor, by feeble pulse, by flabby tongue, by cold congested extremities, has attacked some existing sub-acute inflammation with his most vigorous depressants, and (while the patient's state has from day to day been getting less healthy) has flattered himself that the cornea continued to ulcerate, or the bubo to slough, only because bleeding, antimonials or mercury had been not sufficiently had recourse to. The writer witnessed the following case:—A patient had been for some time treated for deafness by measures which considerably depressed his general health: during this state he showed some spots of superficial ulceration on his glans penis—probably in sequel of herpes, and a pretty broad hint of his then condition of strength; applying with these slight sores to the writer, he was assured they were not syphilitic, and was ordered to take quinine: fidgeting greatly on the subject, he consulted a second surgeon, who advised him to take mercury; which treatment being adopted by the patient, and of course still further deteriorating his health, he began to show symptoms of ulcer of the stomach, and very soon died of hæmatemesis.

Nor is it only depressant treatment which may be overdone. Indeed in the present day fashion sets in the other direction; and perhaps not a little harm results from misapplied alcoholisation of the sick.* The cases in which life is saved, even during inflammation, by the judicious use of alcoholic stimulants, are infinitely more numerous than those where it is saved by bleeding; and the use of such stimulants, in certain cases of inflammation with debility, is among the most important resources of medicine. But the student must learn not to abuse this great medicinal agent; not to prescribe it, as a thing of routine, in all cases of inflammation bearing a certain name; but always to give or withhold, and (if giving) always to proportion it, according to the special requirements of the individual case. For, if treatment is to be indiscriminate, medical advice is but a sham. And there may be death in the practices of van Dunk as well as under the prescriptions of Sangrado.

IV. Book-References.

To digest into a presentable form all that has been written on inflammation, and to show how knowledge of the subject has grown up through the labours of successive contributors, would be an endless task. It could not proceed on the assumption that all, or nearly all, we know about inflammation has resulted from the work of men who have written professedly on the subject, or of men whose fame has been specially pathological:—for in all times there have been great physicians and surgeons, who, not particularly bent on being reputed pathologists, and giving no particular thought to the nature of inflammation, have yet incidentally contributed to our knowledge of it. And so intimately has this knowledge in its growth been interwoven with common practice, that the bibliography of inflammation would in fact be the bibliography of medicine and surgery. Simply to enumerate those authors who have said something worth saying on the subject, would require long and special labour; and to undertake, in so vast a field of study, to apportion originality and merit among the almost innumerable contributors, would imply that the critic had a disengaged lifetime before him.

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* Without referring to cases in which wine or brandy has been wrongly given to patients who rather required lowering treatment, the writer can say that, on various occasions, he has seen a convalescent suffering considerable nervous disorder from merely continuing the large quantity of stimulus which had been necessary to him during earlier periods of his illness. And in one such case the cause of the inconvenience was not suspected, till it had occasioned the patient a first attack of epilepsy.

The utmost that can here be attempted will be a very general statement of what, in the writer's opinion, have been the most important *momenta* towards developing the theory of inflammation taught by him in the preceding pages. And this statement, which can only be offered with diffidence, must at best, so far as it affects persons, be taken with qualification. For in each great step of progress, almost without exception, many individual minds take part. So little, generally speaking, is one active worker ahead of other active workers of his time, that merit of invention is almost invariably contested. Often, where a man most seems to discover, he in truth has but been the swiftest to speak, or sometimes but the most adventurous to guess. Yet just in proportion as his contemporaries are not behind him, his individual utterance is echoed; and his achievement, be it great or little, becomes, by other deserts than his, of multiplied value for progress. Thus, sometimes unjustly, we are led to forget that, to make the one great fame in science, hundreds of less conspicuous labourers may have given lifelong service; and that the single name which History preserves upon her roll has an almost symbolical meaning.

1. The belief which for ages has been implied in men's everyday use of the word "inflammation"—the belief that certain diseases, having many most obvious points of difference (such diseases as pneumonia, enteritis, gout, erysipelas, ophthalmia) have in them, deeper than their differences, one common nature; and that what is thus pathologically common to them is an action identical in kind with that which mechanical and chemical injuries excite in exterior parts of the body;—this belief represents a generalisation of such magnitude and importance, that, though it comes to us, unfathered, from times when perhaps there was less pride of authorship than now, we should be ungrateful did we not acknowledge the debt.

2. Glisson's discussion of the laws of muscular contractility has indirectly been of great importance to our subject. His observation that the texture of muscle is in itself irritable, and may accordingly be stimulated to contract not only through musculo-motory nerves, but by direct irritation of its own isolated material,—this seems to have been a first step towards what is now recognised as the right physiology of textural life. And though Glisson's discovery took comparatively little root in England, yet afterwards, developed by Haller, it became recognised at its full value abroad. There, around it, were clustered other like facts. And the knowledge became familiar, that elements of texture, independently of the nerves and vessels which naturally bind them to brain and heart, have in themselves a source of action and a power of answering to stimulation. The influence of this traditional thought has been great in German pathology. Notions of textural life as a factor in the production of disease have never for the last century been strange to the German mind; and while we in England were still pottering over the supposed hydraulics of inflammation, German pathologists, having already begun to appreciate in such problems the merely ministerial significance of vascular and nervous changes, were well prepared to recognise and interpret those transformations of texture which the texture effects for itself.

3. Without undue partiality, an Englishman may be glad to say that the special study of Inflammation dates from the labours of John Hunter. An indefatigable observer of nature, untrammelled by educational forms, and thoroughly a sceptic in his method of study, this large-minded surgeon of ours went to work at inflammation with a full estimate of the physiological vastness of his subject. He saw that, in order to understand inflammation, he must regard it not as one solitary fact of disease, but in connexion with kindred phenomena—some of them truly morbid in their nature, but many of them within the limits of health. He saw that, for any one who would explain inflammation, all inequalities of blood-supply, all periodicities of growth, all actions of sympathy, were part of the problem to be solved;—that no one could understand the common phenomena of turgescence, much less the phenomena of inflammation, without knowing what regulative influences belong to the blood-vessels, and what endowments reside in the blood;—that no one could divine the meaning of ulceration, unless by first considering what are the powers which effect the wasting of useless parts, absorb dropsies, suck up the products of digestion, loosen the temporary teeth, and open out an unsuppurating space for aneurisms and

tumors. Most vividly he saw that some phenomena in inflamed parts are such as mark a loss of self-preservative power; and he speculated on the general conditions of this power till he found that the study of inflammation can end only with the study of life. Less perfectly perhaps than we by the microscope have been helped to see, but at least more perfectly than any predecessor or contemporary, he saw, that in every part of the body, even "the smallest conceivable," there are powers by which the part "acts for itself only" to maintain its typical constitution; and throughout every page of his writings there burns one omnipresent conviction, that no act of disease can be understood, except through a knowledge of those powers.

From accidental circumstances, Hunter's work on Inflammation has often been less quoted than the works of inferior contributors. His style of writing was bad. Working so passionately at facts, he perhaps was almost contemptuous of words; and, though sometimes his phrases are most graphic, his general argument is hardly ever well conveyed. Especially as a matter became difficult, his command of language seemed insufficient for discussing it; and sometimes his most memorable thoughts are those which he has least skilfully expressed. He cannot be understood without more reflection than average readers will give; and only they who are content to struggle through a veil of obscure language up to the very reality of his intent, can learn with how great a master they are communing.

Likewise it must in candour be admitted that there are crude thoughts, not a few, among his unmatched suggestions of truth. How could it be otherwise with a man whose genius was for ever telling him that his subject was infinite, that he must gather for it explanatory material from every department of nature, that nothing in it could be well understood except with an almost world-wide context, that meanwhile whatever he might say could at best but be transiently true? Surely he felt that it was his business rather to hint than to expound, rather to scatter seed for others than himself to tend the ripening fruit.

Doubtless he was a great discoverer. But it is for the spirit of his labours, even more than for the establishment of new doctrine, that English surgery is for ever indebted to him. Of facts in pathology he may perhaps be no permanent teacher; but to the student of medicine he must always be a noble pattern. Emphatically it may be said of him, that he was the physiological surgeon. Others before him (Galen, for instance, eminently) had been at once physiologists and practitioners; but science in their case had come little into contact with practice. Never had physiology been so incorporated with surgery, never been so applied to the investigation of disease and the suggestion of treatment, as it was by this master-workman of ours. And to him, so far as such obligations can be personal, we assuredly owe it, that for the last half-century, the foundations of English surgery have, at least professedly, been changing from a basis of empiricism to a basis of science. In his day it had not yet been recognised as a safe investment of capital, that a surgeon should begin by getting some little credit for physiological knowledge. To Hunter it was a reproach, that he was more than the handicraftsman. It was not "as a stepping-stone to practice," nor only during the leisure of youth, but as a constant interruption to his earnings, and fondly to the very morning of his death, that he pursued his studies in physiology. It was amid the jeers of the medical market-place, that he stored up those "pigs' pettitoes"—that museum of comparative and experimental physiology, which Europe now appreciates as perhaps the greatest of English contributions to the science which it illustrates.

4. Embryological studies have been of incalculable importance to our subject. Especially the knowledge which about thirty years ago was being acquired through the labours of von Baer and Burdach and Rathke and Valentin, as to the development of organs, and as to the developmental relations between organs and their blood-vessels, was in itself almost an antidote to the prevailing theories of inflammation. And on the acquisition of this knowledge there soon ensued the publication of Schwann's researches as to the development of textures;—a publication, which, partly by the truths directly taught in it, and partly by the immense suggestiveness of those truths, has been of more useful effect in pathology than perhaps any other one man's labour.

5. A more accurate working at textural anatomy followed and is still following that eventful publication; and by degrees during these twenty years minute structure has come to be almost as well known as the older lessons of the dissecting-room. Amid this progress there has shaped itself that better knowledge, to which frequent allusion has been made, of the laws of textural nutrition:—a better knowledge, to which Mr. Toynbee's* paper on the extra-

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* *Researches tending to prove the Non-vascularity and the peculiar uniform Mode of Organisation and Nutrition of certain Animal Tissues;* in *Phil. Trans.* 1841.

vascular tissues of the body, and Mr. John Goodsir's* essays (especially those relating to *Centres of Nutrition*) were early and suggestive contributions.

6. It much conduced to the general progress, that critical inquiry was now made into the structure and functions of blood-vessels; and that, principally through Prof. Henle's researches,† we were led to see that the mystery of textural growth was not to be solved by any discoverable endowment of artery, vein or capillary.

7. The knowledge, which was simultaneously growing up, of the facts of vegetable life,—the knowledge that, throughout half of the living universe, organisation, without nerves and without contractile blood-vessels, suffices for the discharge of functions which we had been too apt to consider respectively nervous or vascular,—the knowledge that in the vegetable organism, nerveless and pulseless as it is, every requirement of textural nutrition is fulfilled, that vegetable cell-structure is irritable, that vegetable cell-life is periodic, that vegetable cell-chemistry is elective, that vegetable cell-growth can be partial and hypertrophic,—this knowledge, gradually becoming familiar to those whose special field of labour is the animal organism, has greatly, though indirectly, influenced their interpretation of facts. And perhaps, even now, the student could not better prepare himself for the problems of human pathology, than by carefully considering such papers on the vegetable organism as have been written by Schleiden and von Mohl.

8. The microscopical researches which Schwann had made so interesting to the anatomists of healthy texture had meanwhile, almost from their commencement, been extended by Johannes Müller and Henle to the principal shaped products of disease, and had established the fundamental belief, that, for normal and abnormal structure, there is but one plan of development.

9. The more accurate study of inflammation from that point of view which is taken in the present essay, may be said to begin with Mr. Goodsir's researches, published in 1845, on the process of ulceration in articular cartilage, and generally on the structures engaged in the processes of absorption and ulceration. Among Mr. Goodsir's inferences are some, which, were he now re-writing his paper, he might perhaps not leave unaltered; but his main points,—that disintegration of inflamed texture results from dynamical disturbance of the texture itself, that veins and lymphatics, in reference

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* *Anatom. and Patholog. Observations*, by John and Harry Goodsir; 1845.

† *Allgemeine Anatomie;* 1841.

to ulceration and absorption, are "mere ducts for conveying away the products of action," that ulceration involves profuse endogeny and shedding of textural germs,—these are among the most important doctrines yet advanced in the pathology of inflammation. In 1847 something further was contributed in this direction by observations then published as to the profuse growth of epithelium in the tubules of the scarlatinal kidney.

10. A step of the greatest importance in its bearing on the study of inflammation was, that in 1847 Dr. Reinhardt settled the meaning of those large oil-containing cells or glomerules which are so abundantly found in many inflammatory products, and which hitherto had been a puzzle to pathologists. His discovery that these forms derive their characteristics from degeneration, that originally they are common albuminous cells—cells of texture, or pus-cells, which, as part of their course to dissolution, acquire a larger size and convert their contents into oil,—this very greatly facilitated the interpretation of many morbid products.

11. It was likewise of much importance to our subject, that, while the microscopy of inflamed tissues was getting to be well observed, there were independent observations going on as to the general pathology of degeneration. When Dr. Richard Quain (1850) had experimentally shown that fatty transformation would spontaneously arise in dead muscle, when Professor Wagner (1851) had shown that it was of habitual occurrence in dead or half-dead albuminous material artificially detained within the body, there could remain no room for doubt as to its pathological meaning. And its extensive prevalence in inflamed parts—a fact which was now becoming notorious, was at once understood to be a sign that the material of such parts was degenerating.

12. In 1852, a first large generalisation of the new knowledge was made by Professor Virchow—himself also a contributor of original observations on the subject, and was set forth by him in a treatise on what he termed *Parenchymatous Inflammation.** In this famous paper he argued against the common over-regard of "effusion" as an inflammatory phenomenon, contended that in innumerable cases of inflammation there is not effusion in any other sense than that of an increased feeding of textural elements, insisted that these elements are themselves the true scene of what is most essential to inflammatory change, and especially urged that the process of inflammation is, in its nature, degenerative. Two years afterwards—writing in introduction to a handbook of Pathology and Therapeutics

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* *Archiv*, vol. iv.

which he had undertaken to edit, he gave papers of the highest excellence on both Fever and Inflammation; papers which, if they did not actually and completely attain, at least, far more nearly than any thing previously written, approached, the great pathological object of interpreting these morbid processes. In 1858, in the light of that greatly increased microscopical knowledge to which meanwhile many scientific labourers had contributed, he published under the title of *Cellular Pathologie*,* a set of lectures, chiefly on textural disease:—and here, discoursing of inflammation, he gave more prominence than before to the germinative changes which are part of it. He especially brought into relief the reasons which there were (not a few of them due to researches which he had instigated) for believing that shaped inflammatory products are lineal descendants of textural shapes—*omnem cellulam e cellula.*

Steps towards this conclusion had been advancing since Mr. Goodsir, in 1845, first made one. An admirable account, more elaborate than his, of the inflammation (unfortunately still under the restrictive title of *ulceration*) of articular cartilage was published in 1850, by Dr. Redfern. Some imperfect, but suggestive, observations in the anatomy of keratitis had been made by Dr. Strube; and Professor Virchow himself had spoken to the productivity of the corpuscles in inflamed cellular membrane. In the microscopy of tumors, moreover, there had been shown numerous instances of successive cellular endogeny,—morbid processes of growth, beginning as the germination of textural cells, and gradually becoming less accordant with the original textural type. And in studying keratitis, Dr. His (1856) had discovered those perfect illustrations which have above been quoted of the textural origin of pus-cells. The crowning work in this department of pathology is that of Professor C. O. Weber; after whose extensive inquiry (referred to in a previous part of this paper) no one can reasonably doubt, either with regard to the process of suppuration, or with regard to other acts of morbid cell-production, but that universally the new cells arise as endogenies of the old, by fissiparous multiplication and growth of the original nuclear material.

13. From forty to thirty years ago the observations of Wilson Philip, Kaltenbrunner, John Thomson, and Gendrin had brought to light some of the microscopical phenomena which are presented in the capillary circulation of irritated transparent parts; and for a

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* Earlier in the year, he had published much of the material of this work in his *Archiv*, in a paper entitled *Reizung und Reizbarkeit.*

while these phenomena had occupied almost the entire attention of persons studying inflammation. But it has only been since the later researches (above referred to) of Prof. H. Weber and Dr. Schuler, that any reasonable explanation of them could be offered; and other inquiries have meanwhile shown that, very important though those phenomena are, they constitute but a small part of what marks the process of inflammation.

14. The better knowledge which, during the last twenty years, has been acquired with respect to the febrile state has greatly, though indirectly, conduced to the pathology of inflammation. The discovery by Messrs. Andral and Gavarret that commonly during inflammation the fibriniferousness of the blood is increased; the evidence collected by many contemporaneous observers as to the amount of waste-products discharged from the febrile body; and the information gained, especially by the labours of von Bärensprung and Traube, as to the connexion of bodily heat with other facts of febrility;—all this, besides directly doing much for the interpretation of inflammatory fever, has by suggestion contributed not a little to elucidate the local process of inflammation.

15. Such studies have of course not been possible except in proportion as progress has been made in physics and in animal chemistry; and there have been other ways, which it would be tedious to detail, where this progress has had part in developing a better pathology of inflammation. The impetus which was given to researches in organic chemistry by the bold generalisations of Prof. Liebig has doubtless been of much service to our subject. And here, where so much has been said of zymotic inflammations, it would be wrong to refrain from expressly mentioning that it was he who first revived the old fermentation theory of fever, stated it in terms of modern science, and supported it with arguments of real analogy.

16. In those departments of our subject which relate to the causes and therapeutics of inflammation, it is less easy to name the persons to whom we are chiefly indebted for progress. A tendency to greater exactness of thought in questions of cause and effect has been part of the general scientific development of our time—belonging not exclusively to medicine, but perhaps rather coming to medicine by contagion from physical and chemical studies. Fortunately, however, it has come to us. And for a pathologist now to talk of "sympathy" or of "constitutional irritation," as they were talked of thirty years ago, would be not less an anachronism than for a chemist to talk of phlogiston.

JOHN SIMON.

ABSCESS.

PUS, one of the commonest products of inflammation, is a creamy yellowish-white fluid, neither acid nor alkaline,—specific gravity 1·021 to 1·040. It consists of serum and pus-cells. The serum contains more or less albumen, in all respects identical with that of the blood. The pus-cells, at first transparent when immature, become yellow from deposit of fatty matter when mature. The quantity of fatty matter in pus varies from 2 to 6 per cent, according to Fownes.

There are two doctrines as to the origin of pus. First, that the fluid is formed out of the exuded plasma of the blood (Rokitansky). Secondly, that it is formed by a rapid cell-growth, set up by irritation in the parenchyma itself (Virchow). The cells from which Virchow considers pus-cells to be generated, are the corpuscles of areolar tissue (*Bindegewebs-körperchen*), which he supposes to permeate nearly every part of the frame. This latter view is the one more generally adopted, although the universal existence of these corpuscles has yet to be proved. Modern pathologists do not regard pus as degenerated lymph. The white corpuscles of the blood, the lymph-corpuscles of the chyle, and pus-corpuscles, are identical and indistinguishable. They differ in their mode of origin. The two former are generated within a vascular system, normally. Pus is generated external to the vascular system, abnormally. Lymph-corpuscles cannot escape from the blood, and pus-corpuscles cannot enter it, except by rupture of vessels; consequently the latter cannot be regarded as a degenerated form of the former.

Inasmuch as pus consists of myriads of cells swimming in serum and formed at the expense of the tissues, it follows that prolonged suppuration is accompanied by a corresponding amount of emaciation and waste of the body. Pus may be readily removed by the absorbents. The serum is taken up as any other fluid. The pus-cells either dry up, when they form a cheesy pultaceous mass, which may ultimately become cretaceous, and has often been mistaken for tubercle; or the fatty matter undergoes granular disintegration, the cell-wall softens, and the whole is removed in the usual manner.

During the early period of histological research, a doubt was very generally entertained as to the possibility of the absorption of pus; and a modern author endeavoured to prove that it was an error to expect in surgical practice the cure of a large abscess without discharging the matter. He argued, that bleeding, purging, vomiting, sweating, or other evacuations, often had the effect of causing the fluctuating tumour to vanish; but this, it was affirmed, was only for a time: "a large proportion of serum had been withdrawn from the contents of the abscess, and these had been reduced to little beyond cells; but as soon as the blood had recovered its natural constitution, the cells (just like the nucleated cells of glands) again exerted their power, and surrounded themselves with their natural atmosphere." It was further stated, that accidental circumstances will often act like the treatment to which reference has been made, and will reduce the fluidity of pus, so that an abscess apparently vanishes; but the cells may remain quiescent an indefinite time, and may presently again surround themselves with fluid blastema, forming the same amount of pus as at first. On such grounds, it was pronounced that the perfect and permanent absorption of an abscess, consisting not only in the removal of its serum, but in the destruction and dissolution of its corpuscles, so that the part shall retain no tendency to the re-accumulation of its previous contents, is "among the very rarest occurrences in surgical practice."

This error gained such ground, that surgeons had to protest against the practice of diligently hunting for a soft and fluctuating point in an inflammatory swelling and forthwith plunging a lancet into it; and some of the journals thought it necessary to record well-marked cases, to prove the complete disappearance of large purulent collections (vide *Medical Times and Gazette*, 1858, p. 295—cases under the care of Messrs. Hilton, Birkett, Critchett, and others). No better illustration of the fact can be quoted than the certain and speedy absorption of purulent effusions under the periosteum, in cases of tertiary syphilis. The doctrine of treating abscesses by bleeding, purging, &c. has for many years been exploded, experience having shown that a cure can be more readily effected by the opposite course. About the end of July 1845, a young gentleman, aged twelve, was brought to Mr. Lawrence, in consequence of his suffering from a large chronic abscess, three inches by two in diameter, situated just below the angle of the left scapula. There was stiffness of the vertebral column, and the abscess was made out to be connected with some morbid condition of the bone. A surgeon had wished to open it, but the parents objected. Rest in the recumbent position, the administration of tonics, and a generous diet, were directed; and on January 14, 1846, about six months afterwards, the boy presented himself again, when it was found that the abscess had completely disappeared.

The time is not far back, when the erroneous opinion here pointed out induced surgeons to adopt the practice of opening the cavity of a joint distended by increased synovial secretion. Microscopic examination had proved the existence of pus-cells in the fluid of an inflamed joint, and their absorption was deemed impossible. The most serious consequences, often involving the loss of a limb, ensued from the proceeding, and the practice was speedily abandoned. I should not have made such marked reference to this subject, had I not found the opinion that pus was not capable of absorption still held, and constituting an important guide to the practice of many surgeons.

To the creamy white fluid known as healthy pus, the term "*laudable*" has been applied. But it may be thin, though of yellowish colour, when it is called *purulent* or *puriform fluid.* Pus stained with blood is *sanious;* when thin and acrid it is *ichorous.* It may contain cheesy-looking flakes, when it is called *curdy.* Pus formed in connexion with diseased bone may contain, according to the late Mr. Bransby Cooper, 2½ per cent of granular phosphate of lime. Dr. Gibb has related a case in which a purulent discharge of blue colour, from the presence of cyanuret of iron, proceeded from the diseased breast of a female, æt. 23, a native of Canada.* The dressings were stained of a blue colour. "The colour," observes Dr. Gibb, "was of a light-bluish green. Caustic potash removed the colour, which it will also do with Prussian blue. The colour was not restored by dilute muriatic acid, which would restore that of Prussian blue. Except when in small quantity, muriatic acid removed the blue colour, but without producing a pink solution. Immersion of a piece of the stained linen in dilute nitric acid removed the colour." The pus was at times fœtid. The discoloration lasted rather less than a month, disappeared, returned in about three weeks, and finally ceased before the patient's discharge from hospital. Dr. Gibb has collected the particulars of ten cases, all presenting similar phenomena: two in the *Gaz. Médicale*, 1831 and 1834; M. Olioli's case in Turin (amputation); a case in M. Maisonneuve's wards (breast); three cases in the practice of Sir Benjamin Brodie; one case (*Dublin Journal of Medical Science*) by Dr. Croker;

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* *British American Journal of Science,* New Series, vol. vi. p. 201; 1850-1.

one case by Mr. Butcher (*Lancet*, and *Dublin Medical Press*); one case by Dr. Gibb.

Dr. Gibb mentions other discolorations which have been noticed in pus, viz. orange-colour, by Dr. Geoghegan,—this fluid, however, proved to be "altered cellular membrane;" slate-coloured pus, mentioned by the same author as a discharge in a case of abscess in the xiphoid cartilage,—"it resembled the colour and consistence of mercurial liniment;" black pus, described by Dr. Bigger;* green pus, common in abscesses of the brain; dark-olive pus, devoid of colour, of creamy consistence, showing under the microscope decomposed pus-globules, mixed with epithelial scales (evacuated from an encysted tumour of the labium); claret-coloured pus, from admixture of blood; brownish pus, from abscesses of the liver, &c.

I cannot say that all these colours as applied to pus are familiar to me, particularly "black," "dark olive," or "slate," &c. Many cysts, however, present when large the characters of abscesses, and contain fluid or semi-fluid secretions of different hues.

The colour of unmixed pus generally varies from light-yellow to white. The presence of blood in variable quantity will give any of the shades resulting from an admixture of red.

An abscess signifies a collection of pus situated in any of the tissues of the body, and circumscribed by a cyst formed of recently-deposited and newly-organised fibrin. Pus may form under many other circumstances; as, for example, from a granulating surface; in the pustules of impetigo, herpes, smallpox; in the areolar tissue of a limb; in the cancellous texture of bone; in the sac of the pleura or pericardium, &c. To none of these conditions should the term abscess be applied: the expression "diffused abscess" is a contradiction. We draw a very proper distinction between diffused and circumscribed suppuration, regarding the term abscess as synonymous with the latter. We find in the examination of morbid specimens of the lung illustrations of what is here stated: a cavity formed by the softening of tubercle is not an abscess; nor is an infiltrated condition of a part of the lung by pus, giving to the lobe a *general* yellow colour. In the one case we speak of a vomica, or tuberculous cavity or cavern in the pulmonary tissue; in the other, of diffused suppuration. But an abscess in the organ exhibits a circumscribed cavity lined by a layer of false membrane with a smooth inner surface. The causes of abscess are numerous; its symptoms, formation, and progress vary, not only according to situation, but also in connexion with the previous condition of the individual. The surgical treatment requires in many cases the greatest amount of care, patience, determination, and skill. And before entering upon the subject more minutely I would repeat that pus may be absorbed as well as secreted; and that the practice of letting out matter as soon as formed, in all cases, is both puerile and reprehensible.

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* *Dublin Medical Press*, 1849.

Abscesses are commonly divided into acute and chronic; but this distinction very imperfectly expresses their variety. It serves, however, as a good basis of classification, if it be remembered that the two gradually merge one into the other. The former may be taken as a type of the disease. A part, previously inflamed and swelled, becomes affected with a throbbing pain, mixed with occasionally sharper paroxysms; the skin covering it becomes glazed, shining, tense, and reddish or pink-coloured: the patient's aspect is worn and pallid, and he suffers from shivering fits. Upon examination the surgeon finds a considerable amount of surrounding œdema, but towards the suppurating part the tissues are firmer and the pain more acute. If it were possible to have the view of a vertical section of an acute or phlegmonous abscess, we should see in the centre a collection of matter enclosed in an organised vascular membrane of variable thickness composed of fibrin, external to which would be seen serous effusion, gradually decreasing in quantity until it ceased in perfectly healthy tissues. However deeply an abscess may be formed, it enlarges by the extension of its wall towards the external integument or in the direction of some internal mucous or serous cavity. When it approaches either skin or mucous membrane, it removes by degrees the blood-vessels which nourish those structures, by a process of thinning or attenuation: the most prominent part so thinned dies and separates as a minute slough, preceded by the casting-off of the epithelium. Thus a small circular aperture is formed through which the pus flows out. In the case of serous membranes the vitality is longer preserved, and the matter often escapes by a rent or tear. At first only a small quantity is discharged; but by degrees the stream becomes larger and uninterrupted, until, by the contraction of the cyst or wall of the abscess, the cavity is entirely obliterated. The external opening then closes and cicatrises. Although much of the sharp throbbing sensation ceases when suppuration has been fairly established, still the process of *pointing*, or the coming of the abscess to the surface, is attended with much pain, and the surgeon may be called upon to assist nature by making an opening with a lancet or scalpel. Let him bear in mind the normal progress of an abscess, and imitate the steps of nature as far as possible, and with the least amount of pain to the patient. He must first ascertain by examination where the matter is situated. The feeling of fluctuation is more quickly perceived by one surgeon than another; a fact dependent upon the delicacy of touch. It is not necessary to grasp a patient forcibly and to press upon the inflamed part with violence: fluctuation is more readily ascertained by gentle manipulation and slight yet well-directed, and sometimes alternating, pressure. When the matter points, it is better to make that the seat of puncture, although it may not be the most depending part, for nature in general will not be interfered with, and the point which she has selected will ultimately burst and become the true outlet.

A bleeding-lancet it too small an instrument for opening abscesses. The surgeon should use a thin yet broad-shouldered sharp-cutting double-edged knife or scalpel. And having predetermined where to make his opening, and the probable thickness of parts to be divided, he should plunge the instrument rapidly and boldly through the different tissues. If pus escapes by the side of the blade, he may, if he think fit, enlarge the incision to the requisite length as he withdraws the instrument. The pus must then be allowed to flow from the wound. There is no need of a probe, nor of any process of squeezing the walls of the cyst, a proceeding extremely painful to the patient. A soft poultice should be applied, and the remainder of the cure left to nature.

There are some surgeons, who, in opening an abscess, hold the knife as if they were dissecting, and cut successively through skin, subcutaneous tissue, fascia, &c. Such a practice should not be tolerated; it shows ignorance on the operator's part, and aggravates the patient's sufferings to an unbounded degree.

In all cases the constitutional treatment must be adapted to the peculiarities of the patient. But as a general rule, we may lay it down that any lowering system of treatment is inadmissible in the case of suppuration. Such measures fail to arrest, though they may disturb, the process which is going on; and we remark that recovery is the more rapid, the nearer the patient's condition approaches that of health.

The practice of leeching inflammatory swellings has of late years greatly diminished. Patients in St. Bartholomew's Hospital are allowed generous diet; and in a certain proportion of cases quinine, opium, wine, or porter, are administered. In 1833 it was the custom to put all girls suffering from venereal disease upon milk-diet, and to purge them by saline medicines. If affected with chancres, they were salivated. I well remember the burrowing sinuses which formed after suppurated buboes. They extended round the thigh, where they were laid open by a curved bistoury run along the director, the operation being repeated over and over again. We rarely see such cases in the present day, where greater reliance is put upon rest and cleanliness, combined with proper nourishment.

The following case is interesting in illustration of the influence of the general health upon the process of suppuration. In 1843 an officer arrived in England from India on sick leave. He consulted Dr. Latham respecting the condition of his lungs, but no conclusive evidence of disease was obtained on examination. Soon afterwards a swelling formed about the left pectoral region. In three weeks' time fluctuation was detected, the matter seeming disposed to reach the surface in two situations; first, about an inch below the clavicle and towards the nipple; secondly, in the axilla. An opening was made in the latter situation by Mr. Skey with a moderately large trochar, when about eight ounces of blackish-brown fluid were evacuated. Examined microscopically, this fluid was found to consist of blood-discs, fat-globules, and serum. In about a week, his health being much improved, the abscess refilled, and, pointing under the clavicle, burst and discharged a quantity of healthy pus. The patient recovered.

Abscesses frequently form about the head, face, and neck. Such an occurrence is very common in childhood, when it is often associated with depressed powers of health, as after infantile fevers, or with that condition of constitution termed strumous. The question may be asked, should we open such abscesses early, or should we allow them to burst? About the scalp they are generally painful, when they may be opened; about the face a cicatrix may lead to unpleasant contractions, so that, as a general rule, we open them in the direction of the line of feature, or of the fibres of the subjacent muscle; for instance, when matter forms in the upper lid, as is frequently the case after erysipelas of the head and face, we make an early incision in the direction of the fibres of the orbicularis palpebrarum muscle. But the surgeon must dismiss from his mind the idea that the cicatrix formed in infancy will of necessity become obliterated, or even remain stationary, during the growth of the child. It will indeed contract for a time, and lose all that peculiar elastic material which was at first deposited, until it becomes a thin, smooth, white patch, differing clearly, but not very markedly, from the normal integument. "Thus a scar or a diseased spot may grow and assimilate as its healthy neighbours do. The scar of a child, when once completely formed, commonly grows as the body does, at the same rate and according to the same general rule; so that a scar which the child might have said was as long as his own forefinger, will still be as long as his forefinger when he grows to be a man."* Mr. W. Adams related to me the case of a young lady, who, when an infant, had a nævus removed from under the left clavicle by extirpation. The surgeon assured the mother that the cicatrix would disappear with years; but, on the contrary, the scar has increased in length from an inch and a half to about four inches, and being situated on the bosom produces an unseemly deformity. But this is an exceptional case; and I am inclined to believe, with Mr. Paget, that "another rule within this is to be remembered—namely, that in these structures there is usually (especially in youth) a tendency towards the healthy state. Hence cicatrices, after long endurance, and even much increase, may, as it is said, wear out; and thickenings and indurations of parts may give way, and all become again pliant and elastic."†

Abscesses in the neck of strumous children are rarely attended with much pain. They form about the cervical glands, and make their way readily to the surface, where they burst, partially cicatrise, and burst again, until the tuberculous matter deposited in the glands has been discharged. Thus a series of deep puckered scars form in the neck, which are a great disfigurement in females. In course of years the red discoloration disappears and the integument regains its normal hue, but the marks are permanent. I do not believe that, as a rule, any good ensues from opening these abscesses. The surgeon had better rely on general measures. In the adult a large cervical abscess connected with tuberculous deposit in the absorbent glands not uncommonly indicates the existence of a similar morbid deposit in the lungs. This is especially the case when the matter has formed immediately above the clavicle.

But in young children an acute and extremely painful abscess may form behind the ear or below the angle of the jaw; the skin becomes of bright-red colour, and the matter is obviously making its way to the surface. Here an incision should be made to relieve pain. The rule is clear in both instances. Surgical interference is required only when nature seems tardy in her proceedings, and productive of pain to the patient.

In the adult the neck is the seat of a deeper and more serious suppuration, which forms under the sterno-mastoid muscle and in the proximity of the great vessels. It generally terminates in an abscess, that is to say, a circumscribed suppuration; but occasionally the matter is diffused, when I have known the disease prove fatal, by interfering with respiration. It generally commences with stiffness of the neck, which the patient refers to cold; then the head becomes twisted to the opposite side, by the action of the sterno-mastoid muscle, which is raised by the swollen parts beneath. The whole side of the neck may feel uniformly hot, hard, and brawny; or a mass of enlarged glands of nearly stony hardness may project from the posterior border of the muscle. The patient cannot open the mouth or swallow in comfort; he cannot rest, or clear his throat; he fears to sleep, lest he should choke. The countenance becomes pale, sunken, and anxious, and attacks of shivering are severe and frequent. Death may ensue from general purulent infiltration and swelling of the cervical glands and the adjacent areolar tissue, or by the abscess bursting into the œsophagus, pleura, or other important structure. A man, æt. 31, was admitted into St. Bartholomew's Hospital with pneumo-thorax on the right side and general emphysema. He had had pain in his throat and difficulty of swallowing for some time before those symptoms ensued, which indicated the penetration of the pleural cavity. After death it was found that an abscess formed in the deep cellular tissue of the neck had burst in two directions—namely, through the upper part of the œsophagus, and through the right pleura into the cavity of the chest.* My colleague, Mr. Callender, of St. Bartholomew's Hospital, has dissected two cases of deep suppuration of the neck, in one of which the pus made its way into the anterior mediastinum; in the other, it surrounded the trachea and extended to the root of the lungs; and Mr. Ballard exhibited at the Pathological Society the remains of a tuberculous abscess which had burst from behind the sternum into the trachea. Sufficient has been said to show that the sooner the deep cervical abscesses are opened the better; the matter may be so deeply seated that the usual scalpel blade will scarcely reach it; but that does not signify, for the fluid will possibly find its way through the opening on the ensuing day. A case of this kind came under the care of Mr. Lawrence, who entered his knife nearly the whole length of the blade without success. During the night the patient's sufferings became suddenly greatly alleviated, and in the morning the poultice was discovered full of healthy pus. The opening is more safely made behind than in front of the sterno-mastoid, and it usually happens that the fluctuation is more perceptible in the former situation. I saw a patient in St. Bartholomew's Hospital in whom a large purulent collection, inclining towards the posterior part of the neck, and causing the usual symptoms,—throbbing pain, loss of sleep, &c.,—had formed within a fortnight. The scalpel was introduced deeply, and gave issue to healthy matter; the patient recovered without an unfavourable symptom. But in many cases, especially if the patient be out of health and weakly, medical supervision should be continued for a considerable time. In the autumn of 1847, a lady, residing in the house of a surgeon in the city, went out in apparently perfect health to a tea-party. She came home with swelled face, and it was supposed she was suffering from an attack of mumps. Some leeches were applied. Swelling and inflammation increased, and the family called in Mr. Lawrence, in the belief that the disease was erysipelas. The neck soon began to swell, and an abscess formed, which was evacuated by puncture. Thick well-formed pus escaped from the incision in moderate quantity, and the opening soon closed. Then an abscess formed in the thigh, and pursued a similar course; next, another over the left scapula; and finally, a fourth formed over the hip. The ultimate result of the case was lost, the patient returning to the country.

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* Paget's *Surg. Pathol.* vol. i. p. 50.

† Ibid.

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* *Pathol. Catalogue*, ser. xxiv. p. 14.

In 1847, a female was in St. Bartholomew's Hospital suffering from a cervical abscess, deeply seated, and raising the carotid vessels, which could be felt pulsating over it. There was numbness of both arms and partial paralysis of the lower extremities. A puncture was made in consequence of impending suffocation, and from seven to eight ounces of thick matter were evacuated. This was followed by immediate relief to all the symptoms, and slow return to all the functions of the limbs. In another case the swelling was at the sides and front of the neck, and over the situation of the thyroid body. Wherever, in such cases, the matter may form, the treatment is the same. A proper opening must be made as early as fluctuation is detected, that the abscess may neither extend into the cavity of the chest, nor burst into parts important to life. The application of leeches is rarely required; but from the general condition of the patient there is more frequent need of tonics and stimulants. Indeed the administration of quinine and wine here seems to assist and to expedite suppuration, and, after an opening has been made, to favour the processes necessary to the closure of the wound. In all instances the state of the patient affords us a sure guide of treatment.

When abscesses form in the proximity of a joint, we have reason to suspect that disease is going on in the articulation. Not that the abscess of necessity communicates with the synovial cavity; but it may be symptomatic of morbid changes in the soft structures or in the bone. A man came under my care, in whom there was a large suppuration under the deltoid and pectoral muscles; I evacuated the matter by puncture, and then ascertained that there was acute disease going on in the shoulder-joint. A similar case came under Mr. Stanley's care in 1857; and in both the severer disease was masked for a time by the painful suppurating swelling. The same remark applies to abscesses about the thigh; and we find that such an event may be the first indication of inflammation of the hip-joint assuming an acute form.

But the abscess may have a deeper and more serious signification. It may indicate the extension of some deep-seated suppuration through the articular cavity to the more superficial parts; and such a case as the following may point out the necessity of the most careful examination on the part of the surgeon. A boy was seen at St. Bartholomew's Hospital, in whom there was an abscess in the upper part of the right thigh pointing over the femoral vessels. Fluctuation extended into the iliac region; there was no pain in the hip, groin, or back. Mr. Stanley made an opening, when there issued a considerable quantity of pus mixed with synovia, the latter separating and floating on the top of the former. Several openings were made at different times; severe pain in the knee came on, the boy became hectic, and died November 10, 1846. On examination it was found that suppuration, commencing in the iliac fossa, had extended through the acetabulum, destroying the hip-joint, and presented itself in the situation where it was first punctured.

In dealing with fluctuating swellings in the proximity of a joint, however, the surgeon must not be too hasty in the use of the knife. There are changes in the synovial membrane producing thickening and interstitial suppurations, which can with difficulty be distinguished from a circumscribed and external abscess. The synovial lining of the thecæ embracing the surrounding tendons may pour forth a considerable quantity of turbid fluid, or even of pus; and it generally happens that the introduction of a lancet into such a collection is followed by marked aggravation of the symptoms attending the articular disease. When abscesses form external to a joint, they are generally very painful, and are attended with heat and redness of the skin; the process of pointing soon manifests itself. An accumulation of fluid within a joint, or in the layers of the synovial membrane, or in the tendinous bursæ, rarely affects the integument, as in the preceding case; and the expression has become proverbial, that "external redness indicates the superficial character of the abscess."

The frequency with which abscesses form in the proximity of a wounded joint, during the processes of repair, is a fact pointed out by the late Mr. Hey: "When (after wounds) the capsular ligament becomes inflamed, the formation of abscesses, attended with a high degree of fever and ultimately a stiffness of the joint, are the common consequences if the life of the patient is preserved."* I would add, that so common is the formation of abscess under these circumstances that the surgeon may consider himself fortunate in preventing the occurrence. When pus has formed, an early opening should be made.

The subject of psoas abscess is treated elsewhere.

There occur cases of abscess in the abdominal walls, some of which are unconnected with disease within the cavity. They may be left to pursue their own course, especially if they show a disposition to come to the surface. But, in dealing with such swellings, we must never forget the frequency with which they indicate intestinal disease. In the Museum of St. Bartholomew's Hospital there is a preparation† exhibiting a portion of the abdominal walls from the right iliac region. The anterior part of the cæcum is united to the peritoneum lining the adjacent muscles; at this part also the mucous membrane of the cæcum is removed, and irregular fungous growths occupy its place. A fistulous canal extends from the cavity of the cæcum through the middle of the growths, and through the adjacent part of the abdominal wall. The patient was a man thirty-five years old. The effects of an abscess bursting into the peritoneal cavity are fatal.

A case was related at the Medico-Chirurgical Society, April 22, 1845, in which Mr. Howell of Risborough found in the groin of a man aged 70, suffering symptoms resembling those of strangulated hernia, a small hard tumour about the size of a hen's egg, lying over Poupart's ligament, about midway between the external and internal abdominal rings. After two days, phlegmonous inflammation took place; and on fluctuation being perceived, the part was opened and four ounces of pus were discharged. On the following morning two worms (*lumbrici teretes*) were found in the poultice. Fæces passed by the wound for three weeks; but the man recovered within two months. During the debate which followed, Dr. Chowne remarked that he had seen a case in which two ounces of quicksilver escaped from an abscess which formed in the groin of a patient who had taken much of this mineral. Fæcal matter passed also for a time, and the wound ultimately closed.*

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* Hey's *Surgery*, p. 355; 1814.

† Ser. xvi. prep. 28.

Many years ago I examined the body of a young lady, who died under the following circumstances: She had been some time previously in the South of France, where she suffered from a dysenteric attack. She, however, apparently had recovered, although she often complained of sudden pain and cramp in the abdomen. One day, while on horseback, she leaped over a small trench, when severe and agonising pain immediately ensued over the whole abdominal region, and she could scarcely reach her home. She dropped from her pony, and died very soon afterwards. On examination it was found that a large abscess had formed in the pelvis between the fascia and peritoneum, and had been separated from the abdominal cavity by the thin wall of the sac. The sudden jerk had ruptured the abscess internally; pus had escaped into the abdominal cavity, and peritonitis of the acutest form had supervened, under which she expired.

Dr. Deutsch† observes, in speaking of this form of abscess, "that to the frequently-occurring puerperal metastases belong abscesses, which are characteristic, inasmuch as they are often the local metastasis of a general 'blood-crasis,' exciting puerperal fever. In a great number of cases no inflammatory attack precedes their formation; and the presence of pus is first indicated by a rigor. So difficult of detection are these collections that the most careful examination, not only externally, but also by the vagina and rectum, are often necessary." He divides pelvic abscesses into peritoneal and extra-peritoneal. The former is, in general, attended with a febrile attack and acute local pain, and appears (1) in the inguinal fossa, more often the right than the left; (2) in the ligamentum latum, also more often on the right side. In the first situation there is an external swelling; in the second, there is none, and pressure adds but little to the pain. But examination by the rectum detects the feeling of fluctuation, and likewise produces severe pain, as does also lying on the opposite side, and the evacuation of the fæces. In these cases we have generally adhesion to the rectum, rather than to the vagina or bladder. The extra-peritoneal abscess usually manifests less febrile reaction and an inconsiderable amount of pain. Its most frequent seat is (1) the spot where the aponeurotic covering of the deep abdominal muscles going to the thigh passes into the fascia transversalis abdominis and Poupart's ligament. Examination by the rectum fails to give any information; that by the vagina is useful only when the abscess is situated on the iliacus internus. In course of time the abscess extends upwards towards the inguinal region, when its presence soon becomes evident. (2) In the pubic region, near the recti and pyramidales muscles, where their presence excites pain. The extra-peritoneal are more common than the peritoneal abscesses in the proportion of two to one.

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* Vide *Lancet*, 1845, p. 648.

† *Prag. Vierteljahrschrift*, lvii. s. 63; 1858.

I do not attach much practical importance to the distinction between peritoneal and extra-peritoneal abscesses, though some useful remarks are contained in the above extract. Inguinal abscesses are readily detected externally. " When pelvic abscess occurs in the female, the spot at which fluctuation is generally for the first time perceived is, according to Dr. Simpson, the roof of the vagina immediately behind the cervix uteri, or to one side, as if where the broad ligament would open below if its layers were separated by accumulated fluid. The exploring needle," observes that distinguished physician, " which is of invaluable service in the examination of diseases, is never used to more advantage than when employed for the exploration of pelvic abscesses, when they happen to be unusually difficult or doubtful in their diagnosis. For, in the common run of cases you will usually be perfectly able to make out the diagnosis without this assistance. In any case of pelvic cellulitis, however, where you are in doubt as to the formation of pus, you may make sure of it at once by pushing an exploring needle into the centre of the tumour."* The author continues, that " the best exploring needle is a long slender thread-like trochar with a wire stilet passing through it. If the pus is thick, it may not traverse the trochar. But if the surgeon, after withdrawing the trochar, blow through, a drop or two may escape from the end. The existence of matter having been established, it should be evacuated by a free incision."

Abscess of the brain is usually a result of direct violence to the cranium, or happens as a consequence of disease of the temporal bone. A man, who had had purulent discharge from the left ear for five weeks, died suddenly. On examination, the petrous portion of the temporal bone was found extensively diseased. In the left hemisphere of the brain there was a cyst, an inch and a half in diameter, containing pus. It was situated immediately over the fissure of Sylvius; the walls were distinct, thin, and smooth on both surfaces, and easily separable from the surrounding cerebral substance.

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* *Med. Times and Gazette,* July 16, 1859.

Abscesses in the loose areolar tissue at the back of the orbit, causing protrusion of the globe of the eye, are not common. Mr. Lawrence relates the particulars of two cases,* in which the local and general symptoms were characterised by an excessive degree of violence. A man between twenty and thirty years of age came to Mr. Lawrence accompanied by his wife, who said he had suffered such agonising pain for the three or four preceding nights that she was afraid he would have gone out of his mind. In this case matter was presenting just under the superciliary ridge. After making a free opening, a large quantity was discharged, and on putting in a probe it went to the bottom of the orbit. In the second case the patient was a child between three and four years old; the local and general symptoms were equally severe; and the matter presented between the lower lid and the globe. In the child vision returned; in the adult the eye remained amaurotic. Although in general, observes Mr. Mackenzie,† inflammation of the orbital cellular membrane is an acute and rapid disease, it, in some cases, assumes a chronic form, so that matter accumulates within the orbit. At length the lids become swollen and red; fluctuation is felt; the abscess bursts, and leaves a sinus, which for a great length of time is apt to discharge matter, even when there is no affection of the bones. It must be remembered, however, that protrusion of the globe proceeds from other causes than suppuration within the orbit, and although it is undoubtedly correct to evacuate the pus whenever it has formed, yet, under the many circumstances of doubt, the surgeon should proceed with every caution.

Mammary abscesses may be acute or chronic; superficial, deep-seated, or between the gland and the pectoral muscle. In whatever situation they may form, the treatment is to be conducted on precisely the same rules as affect abscesses in other parts of the body. Most commonly suppuration occurs during the progress of lactation, the patient being of feeble constitution, and reduced below the usual strength. Among the poor we frequently see a large milk-abscess, as it is termed, occupying a large part of the gland, and formed within six weeks of delivery. The patient's face is pallid and worn; the pulse excessively feeble; the local pain is described as excessive, and the strength seems quite exhausted. It is obvious that antiphlogistic measures are out of the question. Suppuration may be checked, and indeed prevented, by the timely administration of tonic remedies; but in general, sooner or later, the matter forms, when it should be evacuated by a tolerably free incision. Some surgeons fear to use the knife, lest they should injure the lactiferous tubes: such a dread is imaginary. Far more injury will ensue to the organ from the enlargement of the walls of the abscess.

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* *Lancet*, vol. ix. p. 500; 1826.

† *On Diseases of the Eye*, p. 318.

The deep-seated chronic mammary abscess is peculiar in its slow growth, the absence of inflammatory symptoms, its firm, solid, and circumscribed feel, and its liability to be mistaken for a tumour. The cyst-wall is often very thick, so that it is impossible to detect fluctuation. I have seen the entire mammary gland removed by an experienced surgeon under the idea that the tumour was of cancerous nature, and other cases in which such an accident was on the point of happening. An incision, made before the more serious operation, but in the same line, will generally yield the necessary information.

Abscesses seated between the mammary gland and the pectoral muscle mostly depend on tuberculous deposit. They form and burst not uncommonly near the outer border of the mammary gland. Sinuses extend in different directions, and the discharge is for a long time uncontrollable. The patients are for the most part young, and of strumous habits: in many instances there is tuberculous deposit in the lungs. In former times the practice consisted in laying open the sinuses, although this operation required the division through its entire thickness in more than one direction of the entire gland. I venture to hope that this practice no longer exists. The sinuses are but the channels through which the tuberculous matter is washed away; the pus is but the agent for that salutary process; and when in course of years the parts have resumed their normal state, the openings will close without difficulty. We have here but a repetition of the tuberculous deposit as witnessed in the cervical glands, in which situation experience has proved the inutility of an operation. The administration of tonics and of nourishing diet, removal when possible to pure air, combined with unirritating applications and patience on the part of the patient,—these are proper measures on which we may place the greatest reliance.

Acute idiopathic abscess of the testicle is extremely rare. There are two preparations in the Museum of St. Bartholomew's Hospital (series xxviii.) worthy of attention. The first (No. 34) exhibits a testicle enlarged and indurated, with a small circumscribed abscess in the interior. The second (No. 45) shows a testicle, in the centre of which there is an irregular circumscribed abscess, from which a fistulous passage extends through the tunics of the testicle and scrotum. The substance of the testicle around the abscess is indurated. The history of these cases, however, is imperfect, and they may serve only to illustrate the progress of tuberculous deposit.

The progress of tuberculous deposit in the testicle, such as leads to suppuration, is slow and attended rather with discomfort and a sense of weight than with absolute pain. A dragging sensation extends along the spermatic chord, and the patient cannot bear pressure. As the morbid deposit softens and approaches the surface, the integument becomes thin, red, and tender; but the pain is generally such as may be readily borne. The surgeon may make an opening if he think fit, but he should remember, and warn his patient against, the possibility of protrusion of the tubuli seminiferi. The protruding glandular mass relieves itself by discharge from all morbid deposit, and then recedes, damaged and atrophied, within the tunica albuginea. The scrotum becomes puckered and adherent to the cicatrised part. For a further account of this disease the reader is referred to the article on "DISEASES OF THE TESTICLE."

The treatment of abscesses about the urethra, prostate gland, or rectum, will be found more fully described under their respective headings. I may here remark, that in most instances a free and early opening is indicated, not only for the relief of pain, but to prevent damage to important organs. An abscess of the perinæum may be far from the surface; there may be neither pointing nor marked redness of the skin; fluctuation may be very indistinct; but the pain is deep-seated and heavy; and examination finds the skin brawny and resistant. The patient should be put on his back with the knees raised, and a knife should be entered deeply either in the mesial line, or obliquely as in the lateral operation of lithotomy. The pus is often thick and fœtid, and its evacuation affords the patient great relief. In 1857 I saw a case in which a large collection of matter presenting at the nates had been allowed to extend so as to occupy two large cavities, one extending to the posterior aspect of the pubes, the other passing backwards to the coccyx and almost "dissecting out" the pelvic viscera. The rule of procuring an external outlet for the matter as early as possible is obvious, for the case assumes a much more serious character when the neighbouring viscera become affected. Many cases occur in which disease commencing in the hip-joint extends to the interior of the pelvis, where it excites suppuration, which ultimately bursts into the rectum; or the whole circumference of the bowel may be thickened, and permeated with fistulous passages. Abscesses in connexion with disease of the rectum, on the other hand, may extend into the bladder,* or into the peritoneal cavity,† when death ensues from acute inflammation of the serous membrane.

Among the rarer forms of abscess requiring immediate opening are those termed retro-pharyngeal. Two specimens have lately occurred in St. Bartholomew's Hospital; one under Mr. Skey's care, the other under my own. Hölzle‡ relates a similar case. A powerful young man, aged fifteen, experienced pain and swelling at the back of the throat, with inability to turn the head or to open the mouth. There was a painful swelling in the region of the right parotid; the tonsils were normal; there was no fever. For the first fourteen days the symptoms were sometimes severer, sometimes easier; on the sixteenth day there was hæmorrhage from the mouth and nose; on the eighteenth spontaneous opening of the abscess, with discharge of a quantity of bloody, wine-lees-coloured matter. Behind the soft palate the swelling was still visible. After some hours, about a pint of bright blood suddenly flowed from the mouth and nose; its source was never discovered. Four days afterwards there was a fresh discharge of blood, in this instance from the mouth alone, and on the following day a yet severer hæmorrhage from the nostrils. The external swelling became larger and more painful. The abscess opened a second time in the fourth week, under precisely similar circumstances, with ease to the patient, the cessation of cough, &c. The internal swelling pressed the uvula forwards, but diminished in accordance with that situated externally. The patient died suddenly in the night of severe hæmorrhage, which recurred after an interval of fourteen days. On examination after death, a carious piece of bone was found on the front surface of the body of the atlas. In the cellular tissue, between the tonsil and parotid gland and about the branches of the carotid artery, there was a cavity, the size of a hen's egg, filled with bloody coagulum. The immediate source of the hæmorrhage was still uncertain. There were two small openings through the wall of the abscess into the mouth. This case is interesting in connexion with one which recently occurred in St. Bartholomew's Hospital under the care of Mr. Stanley. A slightly-built man, æt. 24, suffering from swelled tonsils, had a puncture made in the throat below and somewhat towards the outer margin of the left tonsil by a surgeon on the evening of Friday, October 23. He went home apparently without discomfort, although the bleeding seemed to have been considerable at the time. On Monday night the bleeding suddenly recurred, and he came to the Hospital in alarm. On the following morning another attack of arterial hæmorrhage supervened, and between ten o'clock A.M. and two o'clock P.M. he had lost a pint and a half of florid blood. Mr. Stanley, with the full concurrence of all his colleagues, immediately tied the left common carotid artery. No subsequent hæmorrhage supervened, but the patient died in the Hospital two months afterwards of softening of the brain. A case of hæmorrhage from the tonsil is related in the *Medical Times*, December 24, 1859. A charwoman had a puncture made in each tonsil by a surgeon, in the hope of letting out pus. Free hæmorrhage ensued on both sides. In the course of twenty-four hours the bleeding recurred. She was then admitted into the St. Marylebone Infirmary, under the care of Mr. Henry Thompson. "The patient was propped up in bed, pale, almost pulseless, and unable to speak so as to be understood. The mouth and fauces were filled with coagula. Mr. Thompson determined, before putting a ligature round the carotid, to try the effects of the perchloride of iron. This was done by carefully mopping the part dry by means of lint wrapped on the left fore-finger, and then pushing a glass brush dipped in the fluid into the incision. After a few applications the bleeding was entirely stopped; no return took place, and the patient recovered." It would be vain to speculate, without further evidence, on the immediate source of the hæmorrhage in these cases; namely, whether it be from the internal carotid, the tonsillar artery, a branch of the ascending pharyngeal, or some abnormal branch. But a practical rule may be deduced. Never let the surgeon make a puncture into an inflamed throat, unless he be sure that matter has formed and is near the surface.

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* Mus. St. Barth. Hosp. ser. xvi. prep. 34.

† Ibid. ser. xvi. prep. 69.

‡ *Würtemb. Corresp. Blatt.* xiv. 1858.

It will be seen that the formation of abscesses may occupy either a few days or several months; and that we are justified in applying to the former the term "acute," and the latter "chronic;" but we must remember that between these two the "shades are infinite." The following is a good illustration of a chronic abscess: "A healthy-looking girl, aged nineteen, experienced sharp, darting pains in the left buttock eight months previously. She soon after noticed a swelling, which has gradually increased up to the present time. When quite quiet she is easy, when she walks she limps and feels pain. The integuments, loose and healthy, cover a tumour the size of the closed fist, hard and apparently bony, but with one softer point, attached to the left ilium near the sacro-iliac symphysis. There is no preternatural heat, nor is the part painful when examined. The girl has once experienced difficulty in making water." She was ordered generous diet and quinine, and rested in bed, poultices being applied from time to time. In the course of a month one part became more prominent and fluctuating; and in the course of a few days a large collection of fluid was detected. The patient went to the sea-side, where shortly afterwards the abscess gave way and discharged itself. The last accounts of the girl were that she was convalescent. The interesting point in the case is the length of time which elapsed between the first symptoms and the clear manifestation of the disease.

The term *abcès froid*, cold abscess, is applied to such a case as the following: A man, æt. 65, while nursing his wife, who was dying of a lingering disease, fell from a chair, overpowered with sleep, three weeks previously. He was admitted into St. Bartholomew's Hospital, April 7, 1857, with a large abscess, unattended with heat, redness, or pain, situated in the right thigh. An opening was made by Mr. Lawrence, and *three quarts by measurement* of thick purulent fluid were evacuated. The opening was then closed, and the case ultimately did well. Such abscesses may form in any part or tissue of the body. They may be small or large; the cyst thick or thin. They may slowly come to the surface, or remain stationary for years. The cyst may be so full as to present a tumour of incompressible hardness; or it may be thick-walled, and contain only a moderate amount of fluid. In the latter case it may, upon examination, convey to the fingers the sensation of a sharp rim of bone with a depressed centre, such as is common in cases of extravasation of blood under the scalp. As already stated, I have known the mammary gland extirpated for supposed scirrhus, the disease proving to be a thick-walled, deeply seated, tense, slow-forming abscess. M. Erichsen attended with Dr. Boott a gentleman who had a large abscess in the iliac fossa, which had been perfectly stationary for nearly two years. "In the cancellous tissue of bone," observes the same surgeon, "abscesses may exist for an indefinite period, unless opened by surgical operation." To Sir B. Brodie is due the merit of first directing the attention of the profession to the last class of cases, and of pointing out how relief is to be obtained from pain by the timely use of the trephine, as well as how the extension of the disease towards a neighbouring joint is arrested by the evacuation of the cyst (vide "DISEASES OF BONE").

Inflammation and suppuration of the hand scarcely comes under the strict definition of an 'abscess.' The same remark applies to suppuration within the thecæ of tendons. In both these instances we commonly have an absence of that distinct cyst which gives to an abscess its distinguishing characteristic. Yet we should not pass over in silence so important a disease, which, as it occurs for the most part from accident in the vigorous and healthy, requires some peculiarity in treatment. Acute inflammation of the hand may supervene, on a comparatively trifling injury, such as a wound with a small splinter of wood, or a scratch with a piece of bone. In the course of a few days, the hand and forearm become red, swelled, and tense, the former being by comparison twice the thickness of the normal member. Abscesses may form both on the back and palm of the hand; or suppuration may ensue in the thecæ of the tendons, and spread under the annular ligament among the muscles of the forearm. The hand is heavy; the fingers stiff and semi-flexed; the patient is deprived of rest, and has no appetite; the tongue is furred, and the pulse of the affected side beats with twice the fulness and force of that on the opposite. If the disease be not checked, the tendons slough, or become contracted; the muscles get glued together; portions of the phalanges may die and exfoliate; and the patient, after months of suffering, recovers with a useless limb. From considerable experience in the treatment of these accidents, I should say that the old-established principles of antiphlogistic treatment are here very generally applicable. The abstraction of blood by venesection from the inflamed limb relieves the engorgement of the blood-vessels. The pain, previously excruciating, becomes more supportable; while the process of suppuration, if already established, continues uninterruptedly, but in a limited extent; so that when, at an ensuing visit, the surgeon opens the collection which has formed, he finds that the parts are ready to resume their normal state. There are cases, it is true, in which gentler measures may suffice; but they are the exception, for it will be found that no single venesection can produce that amount of debility and exhaustion which will inevitably follow protracted and repeated suppuration. In the class of cases here alluded to, we have not to deal with an enfeebled constitution, nor with an inflammation expressive of other and more serious disease. The case is of purely local origin, and is proportionately sharp and severe. It is surprising how small an amount of disease, in this part of the body, will excite almost insupportable suffering. During the month of October 1859, a poor woman who had had suppuration at the end of the last phalanx of the forefinger, came to St. Bartholomew's Hospital. For several days and nights she had been ceaselessly racked with pain, which nothing except large doses of morphine could alleviate. In more violent forms the inflammation may spread to the wrist-joint, when death of the carpal bones ensues, and the movements of the hand become permanently impaired. Suppuration along the thecæ will be followed by contraction of one or more of the fingers from adhesion of the tendons to the sheath.

On various methods of opening an abscess. The employment of small knives, not unlike those used for the subcutaneous division of tendons, has been strongly recommended by some surgeons for the purpose of opening abscesses. It has been urged that a minute aperture relieves tension and allows the escape of the matter as satisfactorily as a larger one. The plan has been recommended in cases of suppuration in the thecæ of tendons, of psoas or lumbar abscess, of mammary abscess, &c. I am not in favour of the proceeding, regarding it as generally insufficient. In some cases, where it is desirable to secure the complete evacuation of the cyst, a trochar and canula may be employed; but this measure does not offer any advantages over the common incision, while the canula is apt to become clogged by some of the thick matter which is often found floating in the midst of the pus. It received the sanction, however, of the late Mr. Vincent. If it were very desirable to evacuate the contents of a large abscess without admitting air into the cyst, the surgeon might accomplish his purpose with "Thompson's trochar," which provides for the escape of the pus through an elastic tube fitted to the under part of the canula. It is an error, however, to suppose that the admixture of air with the pus is the great danger to be apprehended, or that exploring needles and small canulas may be used with impunity in all cases. Many large abscesses, freely opened, continue to discharge healthy matter for many weeks; while the introduction of a small needle has been followed by inflammation of the cyst of the abscess and general constitutional disturbance. In opening chronic abscesses, a valvular incision is recommended. This may be effected either by passing the knife obliquely, or by drawing the skin in such a way, that when it resumes its normal station, the opening made through it does not correspond with the opening in the cyst. To such a proceeding there can be no objection, especially when it is wished, as in cases of lumbar abscess, to let out some of the matter, and then to close the opening with adhesive plaster. A method recommended and practised by some surgeons, namely, to pass a long narrow knife through the skin at a little distance from the abscess, and then under the skin into the sac, so that the pus may pass through a subcutaneous canal that shall be perfectly valvular and exclude the air, finds favour in modern works. The proceeding is harmless, provided there be a sufficient aperture for the escape of the pus; but I am not aware that it possesses any real advantages over the usual method. The destruction of a portion of the skin with caustics, such as potassa fusa, or potassa cum calce, is generally objectionable, inasmuch as it inflicts on the patient needless pain without any corresponding advantage. The part is first covered with a piece of adhesive plaster, which has a portion cut out exactly of the same figure and size as the opening intended to be made in the abscess. The best way of making the eschar is to dip the end of the caustic in water, and to rub it on the part till the skin becomes brown. The active substance is then to be immediately washed off with some wet tow, the plaster is to be removed, and an emollient poultice applied.

The practice of opening an abscess by a seton needle, and of leaving in the silk, that the matter may drain away, is in every respect objectionable; the opening is of necessity small, and the presence of a foreign body dangerous. And the latter objection holds good with regard to the drainage-tubes recommended by M. Chassaignac, and now so universally popular. If a proper opening be made, there can be rarely any occasion for a drainage-tube; and however carefully it is inserted, it must of necessity inconvenience and distress the patient. I have tried this plan, and seen it tried in cases of empyema, when more harm than good ensued. The irritation excited was considerable, and the pus did not always flow out readily through the tube.

Injections of bromine or iodine have been employed with advantage in cases of chronic abscess; they seem to check the secretion of pus by changing the action of the vessels on the cyst-wall. Inflammation is not a necessary result. The abscess should not be complicated with any deep-seated source of irritation, such as disease of the bone. The strength of the injection is usually one part of the tincture to seven of water. I must confess, however, that the practice, once much extolled, has become very limited; those cases being best suited for it, which do very well when treated on the usual plan.

The character of the contents of abscesses varies greatly. Pus may be thick and creamy, or of almost watery consistence; masses of thicker matter may float in a thin fluid. It may be universally tinged with blood; or, on the other hand, retain its colour, and surround dark brown or black blood-clots. The odour may be so faint as to be scarcely perceptible, or fœtid in the highest degree. The fœtid odour may continue after the opening of the abscess, or cease in the course of a day or two. In other instances the pus seems to undergo a process of decomposition, and to acquire a fœtid smell from exposure to air. With these different points the surgeon should be acquainted, that he may employ such remedies as the charcoal poultice, or chloride of lime, &c. to correct the effects in the atmosphere, which the patient must of necessity breathe.

HOLMES COOTE.

SINUS AND FISTULA.

FISTULA and SINUS, terms of nearly similar meaning, are the surgical names of (1) long, narrow, suppurating canals (*e.g.* fistula in ano, mammary sinus, &c.); (2) canals giving unnatural exit to secretions (*e.g.* gastric fistula, biliary fistula); and (3) unnatural apertures of communication between mucous canals or cavities (*e.g.* vesico-vaginal fistula). If a distinction is to be made between the terms, *fistula* should be applied to the second and third of the above-named three forms of disease, and to those examples of the first form in which the suppurating canal has two openings; and *sinus* should be applied exclusively to those of the first form in which the canal has but one opening. In these meanings the two names will be here used, although the diseases to which they are applied have so many things in common, that it is advisable to consider them under one heading.

If we except the fistulæ, or fistulous openings, that are formed by direct communication of two closely-adjacent canals, as the vesico-vaginal, or the vagino-rectal, the most general characters of fistulæ and sinuses are, that they are canals of much less width than length, lined with ill-formed granulations, discharging a diseased purulent fluid. The canal may be of equal width throughout, as in many perineal and anal fistulæ; or, being narrow at one end, it may at the other dilate into a large cavity, as in many cases of sinus in the breast or the subcutaneous tissue. No general account can be given of the length, or direction, or branchings of such canals; in all these respects there are multiform varieties. So, of their number in any part: one is more common than two or more; but ten, or perhaps more, may exist, as in the worst cases of urinary fistulæ.

In structure, the walls of fistulæ and sinuses differ according to their duration and many other circumstances. When they have existed long, *e.g.* for one or more years, and are not inflamed, the walls are commonly hard, "callous," not highly sensitive or easily bleeding, and formed of condensed connective tissue, inseparable from the adjacent structures. In the more recent states, the walls are soft, like ordinary layers of recent granulations, sensitive, readily bleeding, and easily broken through. In diseased states, they may be, as the surfaces of ulcers may be, inflamed, spongy or œdematous, exquisitely sensitive, or sloughing.

In correspondence with these differences in the obvious characters of the walls of fistulæ and sinuses, the granulations lining them are various. In old cases, they are dense and firm, smooth on their free surface, with scarcely a trace of granular or papillary arrangement. In recent cases, they are often coarsely granular, dusky, and soft. In all cases, they are unhealthy, having little or none of that tendency to mutual union, or the development of cuticle, which belongs to the typical granulations of healing wounds and ulcers. And this unhealthiness may be traced in their minute structure; for, of the granulation-cells, few show marks of healthy development, and many are granular, or filled with fatty particles, or not distinguishable from pus-cells, or imbedded in molecular débris-like substance.

The pus agrees with this character of the granulations. It is never like that of a healing wound (the type of good pus) unless the fistula or sinus be healing; but is thin, watery, turbid, or flocculent. Moreover, it may be mixed with the secretions of the part into which the fistula opens,—as urine, fæcal matter, saliva, &c.

The *orifices of fistulæ*, by their varieties, determine certain designations. If there be two, the fistula (or sinus, as some would still name it) is called complete or open; if only one, incomplete, closed, or occult; if the one orifice open through integument, the fistula is called external; if into a mucous cavity or canal, internal.

The external or integumental orifice is commonly very small; so small that it often closes, or is covered with a thin scab, till discharge accumulating beneath breaks it open again. Often, when the walls of the canal are soft and œdematous, as in cases of abiding irritation from a foreign body, or from dead or diseased bone, a small lobe of soft granulations projects at and conceals the orifice, or elevates it above the surrounding skin. In very chronic cases, the outer orifice is often depressed in hard and thickened integument, and is like a hole in a scar; in some more recent cases, especially near the anus, it is wide and with compressed margins, like those of the Eustachian tube.

The internal orifice has fewer varieties. It may be, or form part of, a deep ulcer of mucous membrane; but, more commonly, it is a simple round opening through apparently healthy membrane, level with or slightly upraised from the surrounding surface.

The structures through which a fistula or sinus passes may, in recent cases, be little changed; in old cases they are usually hardened just round it; and where repeated suppurations have taken place, forming new canals or branches of those already existing, it is common to find all the adjacent structures confused in a hard, brawny, sodden substance, covered with coarse granular or almost warty skin. Such is the state in many of the worst old cases of perineal fistulæ. Where sinuses extend into bone, the immediately surrounding bone is, in recent cases, usually soft or not obviously changed in structure; but in those of long standing it is commonly solidified and hardened, forming a kind of compact osseous canal or cavity lined with a firm, smooth layer of granulations.

The foregoing account relates exclusively to the fistulæ and sinuses that open through either the integument or a mucous surface, or through both. When a fistula is a communication between two mucous cavities or canals, as in the vesico-vaginal, recto-urethral, and others of the like kind, the state of parts may be similar to any of those just described, if the origin of the fistula were in suppuration between the two cavities. But if its origin were in sloughing, or violence, or wound, the fistula is more commonly like a simple short canal or aperture between the two cavities, and the boundaries of the aperture are not granulating or suppurating surfaces, but like healing or healed wounds. In the latter case the edges of the aperture are scarred, and the respective mucous membranes of the two cavities are continuous over them.

The modes of formation of fistulæ and sinuses are numerous, but may be referred to three chief divisions, as dependent on abscess, wound, or gangrene and ulceration.*

Abscess is by far the most frequent origin of these diseases. The simplest cases of sinus (or incomplete fistulæ) are those in which an abscess, with a comparatively large cavity formed in loose tissue, has an opening too small for the discharge of its contents. The chances of such an abscess becoming sinuous, through defect of healing, are increased if a great part of its cavity is below its opening and is "bagging," or if the cavity is deep and the opening traverses textures of various densities, as muscle, or tough fascia, or the mammary gland. In these cases, which include a great proportion of the sinuses extending under muscles, as the orbicularis, glutei, and rectus abdominis, or under fasciæ, as those in the calf and thigh and pelvis, the hindrances to healing are chiefly mechanical. The pus cannot get away so fast as it is formed, and it not only keeps the walls of the abscess apart, but irritates and presses them till, even though they may be very nearly in contact, they will not cicatrise or unite.

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* Congenital fistulæ, such as the branchial, urachal, and others, are not considered here. We know their anatomical, but not usually their pathological, origin.

The tendency of an abscess to become sinuous, through mechanical hindrances to healing, is greatly increased by coincident disease, whether constitutional or local. Hence, the greater frequency of sinuses after chronic than after acute abscesses, because the former occur so generally in those of defective health; and hence, in part, the frequency of rectal fistula in the phthisical. In like manner, fistulæ and sinuses are especially likely to remain after suppuration in strumous inguinal and cervical lymph-glands, or in a strumous testicle, or in the tissue about a diseased rectum, vagina, or urethra.

Another group of cases of sinuses (or incomplete fistulæ) are to be referred to the formation of abscess in connexion with the presence of foreign bodies or some abiding irritation, as dead or diseased bone or tooth. Such are the sinuses connected with necrosis, caries, diseased joint; the so-called dental fistula, leading to a dead or diseased tooth-fang; the sinuses leading to bullets or other foreign bodies.

Abscess is, again, the most frequent origin of complete fistula. Thus, an abscess forming in the neighbourhood of the rectum, after burrowing in the soft adjacent tissue till it nearly lays bare the wall of the bowel, may open or be opened through the integument by the anus. At any time after its discharge, but usually soon after, ulceration through the bared and thinned wall of the rectum forms its second or internal opening, and the contracting abscess becomes a fistula. So, a perineal abscess may first discharge through the integument, and then open into the urethra. But in either situation the course of events may be other than this, *i. e.* an abscess may open, first into the mucous canal, and then through the integument; or ulceration from within the mucous canal may penetrate its wall, and give rise to the formation of an abscess external to it, which may then open through the integument, and thus finish what is requisite for a complete fistula.

In an old case of fistula it may be impossible to determine in which of the three modes of formation just indicated it had its origin, for the result is in all the same. But the observation of cases in process of formation makes it certain that the order of events may be thus threefold; and proves that there is a remarkable liability both to the formation of abscess in the immediate vicinity of disease in a mucous canal, and to the penetration of the walls of the canal by ulceration extending from a discharged abscess. And the liability is not exhausted by the formation and discharge of a single abscess; for it is to the repetition of similar events that the multiplication of branches and new tracks of fistulæ must be ascribed, which are so frequent in the neighbourhood of diseases of the rectum, urethra, and other canals and cavities.

Wounds may be the origins of sinuses and fistulæ, in the simplest manner, when they pass, with long or tortuous tracks, through many structures, and do not quickly heal. Thus, gunshot wounds may become sinuous, even though no foreign bodies remain in them; and parts of the wounds of stumps that have become indurated may, without death or disease of the bone, remain unhealed though contracted into the shape of canals. But with much greater frequency wounds lead to the formation of fistulæ when they penetrate mucous cavities or canals, and give exit to secretions, such as urine or saliva. The chance of their doing so is greatly increased when the secretion can escape through them more easily than through its natural passage. Thus a cut into a healthy urethra is, on the whole, rarely followed by urinary fistula; but a cut into one behind a stricture seldom fails to become fistulous unless the stricture be cured. In like manner, the opening of tracheotomy often fails of healing when the operation has been performed for disease leading to contraction of the glottis; for the artificial opening will give easier passage to the air than the natural one.

Ulceration and sloughing may in many evident ways give rise to fistula. As already mentioned, ulceration through the wall of the rectum may lead to abscess external to it, and the abscess may open through the skin; or ulceration behind or through a stricture of the urethra may lead to urinary abscess and fistula. But without abscess-formation, a sloughing or phagedænic ulceration, or a spreading gangrene, may lay open the urethra or any other canal or cavity, and the opening may become fistulous. Cancerous ulceration is a frequent cause of fistulous communications between the bladder and vagina, or vagina and rectum, or other adjacent canals; and sloughing of the walls of the vagina and bladder is the most frequent cause of the vesico-vaginal fistulæ after tedious parturition.

The general pathology of fistulæ and sinuses, which is here recorded, will receive full illustration in later portions of the work, in the essays relating to diseases of particular organs, as the rectum, urethra, &c. In them, also, the several methods of treatment appropriate to the disease in each locality will be described. Here only the general methods and principles of treatment will be considered.

The methods of treatment may be thus enumerated: general improvement of the health; removal of foreign bodies or occasional irritants; pressure; drainage; injection; seton; cautery; laying-open; tent; plastic operation.

General improvement of the health may be necessary for the healing of any fistula or sinus, but chiefly it is so for those which follow chronic abscess connected with a strumous constitution, or which remain in the incomplete healing of deep abscesses or wounds, as of stumps. Many such an one, after remaining long unchanging in a hospital, has healed in other air; or, in an ill-fed patient, has healed with good food. The general condition of the health is always to be looked to; but the special means of remedying its defect (if any exist) must be determined for each case separately.

The *removal of foreign bodies*, or of occasional irritants, such as excretions, when they flow over fistulæ, is an obvious remedy. But it is not always sufficient; for the walls of the fistula may have become so diseased, that the removal of the original cause of its formation may leave them too unsound for healing. These, however, are only occasionally disappointing exceptions to the rule, that the removal of a foreign body, *e.g.* of a piece of dead bone, a bullet, a ligature, a dead or diseased tooth, or any other, is followed by the healing of any sinus or fistula connected with it. Similarly, healing generally follows when, for example, in a recent case of urinary perineal fistula, the passage of urine by the urethra is made so completely free that none passes the wrong way.

Pressure is seldom effectual for the cure of any fistula or sinus, except those that are recent and subcutaneous, or in a part which can be very uniformly compressed against an unyielding surface, as the mammary gland. In these, or in stumps, it may often be used with good effect; but in older, deeper, and more complicated cases, it is scarcely worth trial.

Drainage, for which the perforated caoutchouc tube of M. Chassaignac is a very happy invention, is applicable to a great number of cases; but chiefly to those in which a sinus or incomplete fistula depends mainly on pus collecting at a level below, or distant from, the aperture of discharge, or, more generally, when pus is apt to be retained. Numerous instances of suppurating tracks about diseased joints, or following chronic abscesses, or lying deep in a limb or mammary gland, or in the course of suppurating lymph-glands, are of this kind. In some cases of the kind it is sufficient to make a counter-opening, through which the pus may, by its own weight, flow away; but when this is insufficient, a drainage-tube should be inserted in the whole length of the canal, for the sake of its use in both securing the exit of pus and acting as a seton.

Injection of stimulant fluids is chiefly useful for long sinuses of old standing, running deep, and where counter-openings cannot be safely made. Such are many of those that follow pelvic abscess, or lumbar or iliac abscess, not connected with diseased bone (for where bone is diseased, injection is very rarely useful). It may be used also with success in sinuses leading into diseased lymph-glands. The best materials are, the compound tincture of iodine; or solutions of iodine in water, in the proportion of from 5 to 10 grains of iodine, and 10 to 20 grains of iodide of potassium, to the ounce of water.

Setons may find their use in many of the same cases as drainage-tubes, but are seldom preferable to them, since the tubes not only act as setons, but secure the discharge of pus with more freedom and cleanliness than any other kind of seton can. In some fistulæ, however, in which the track is too small for a drainage-tube, a seton of one or more wires or silk threads may be usefully employed to vivify the granulating walls and bring them to coalescence.

Cautery, actual or potential, and especially the galvanic cautery, is of great value in two classes of cases; namely (1) in the short canals or mere apertures of communication between adjacent mucous cavities, as the vesico-vaginal and others; (2) in the old long and narrow fistulæ leading into the urethra or rectum. Among the former, those which are small and recent, or such as remain after a nearly successful plastic operation, are especially suited for the cautery, which acts by gradually contracting and finally closing the apertures by repeated scarring.

Laying open is one of the most generally applicable methods of treatment of nearly all sinuses and fistulæ. As examples, the cutting up of long sinuses in strumous inguinal glands, and the ordinary operation for fistula in ano, may be cited. The principle of all such proceedings is, to expose the whole extent of the suppurating canal or cavity sufficiently to permit its being "dressed from the bottom," *i. e.* covered with lint or other material, prevented from closing, and permitted to heal by its own scarring and by the levelling of its borders.

A process, essentially similar to this, but rarely preferable to it, is that of slowly dividing the parts over or enclosing a fistula by gradually tightening a wire or cord passed through it. As the parts enclosed within the loop thus formed are gradually divided, so those without or beyond the loop are gradually healed, being made to granulate directly after they are divided by it.

In some cases it is necessary not only to lay open the sinus or fistula, but to destroy its walls with caustic, or by cutting or scraping. It is so in some old callous fistulæ in the soft parts, and more generally in those of bones, or in those that lead down to diseased, though not dead, bone.

When excretions, as urine, pass through fistulæ, neither laying open nor any other proceeding is likely to be useful, unless free passage is provided for the excretion by its natural means of escape.

Tents and the like means for gradually widening fistulous passages may be sometimes preferable to the quicker widening by cutting; but they are rarely used, probably because they are comparatively tedious.

Plastic operations are adapted almost exclusively for such short fistulous canals and apertures as the vesico-vaginal, vagino-rectal, and others that follow violence or sloughing. For the larger apertures of this kind they alone are useful.

JAMES PAGET.

GANGRENE.

BY the term "mortification" is meant the death of any portion of the living body. Gangrene implies a spreading destructive process, attended by progressive loss of vitality in the living tissues, of which sloughing phagedæna, or hospital gangrene, offers a good example. When soft parts are dead, they are said to be in a state of sphacelus. A more limited dead portion of the body is "a slough." Death of bone is termed necrosis; the dead piece a sequestrum; the process by which the dead bone is separated from the living is called exfoliation. Some authors apply the term "necrosis" to death of any tissue; others extend it from bone to death of cartilage only. The modern views of the life of the blood have given rise to the term "necræmia," or death of the blood. But these different terms have been used loosely, and it would lead to no practical result to attempt any very strict definition. When the destructive process goes on internally and in parts concealed from view, such as the lung, the liver, or any similar structure, we say that gangrene is going on in the organ; that its tissue is "breaking down." A separated and ejected portion is a slough. In these cases, although we judge of what is taking place by symptoms only, we employ the same terms as are applied to gangrene and mortification of external parts.

Pathologically speaking, it is true that what is ejected from the tissues in the ulcerative process is dead; but so long as it is in the form of minute particles, visible only with the microscope, we speak of the disease as ulceration, not sloughing or mortification: the two processes are, however, often mingled; a familiar illustration being afforded by sloughing phagedæna, a disease at one time not uncommon in the venereal wards of the London hospitals. Here the ulcerative process proceeds with such rapidity, that there is no time for molecular disintegration of the diseased tissues; the ulcerative and sloughing processes go on, as it were, hand in hand. There are, also, cases of syphilitic ulceration, accompanied by death or mortification of a circular portion of the integument and the subjacent areolar tissue; and Dr. Baly has noticed, in his observations on dysentery, how even the smallest and most superficial ulcers of the intestine are preceded by the death and detachment of portions of the mucous membrane with its covering of basement membrane and epithelium.* Still, surgically speaking, there is a wide difference between ulceration and mortification. A man suffering from an irregular and large syphilitic ulcer of the penis may pursue his avocations and indulge in his usual diet; but when once a portion of the organ perishes or sloughs, small as is the part affected, the pulse rapidly sinks, the extremities become cold, the expression of the countenance is anxious, and the muscular strength fails. When a larger portion of the body dies, such as part of a limb, the symptoms are proportionately more severe.

Mortification may proceed from a variety of causes: from local violence; from the application of heat or escharotics; from the action of certain animal poisons, such as the urine or the variolous poison; from inflammation in a part where, to use the language of Hunter, there is no increase of power, but, on the contrary, a diminution of it; from arrest of circulation, or even, in some cases, disturbance of it, &c. Two or more of these causes may be combined: mortification may be immediate, or more slow and consequent on other well-marked changes. It may be limited, or may spread; the parts affected may be dry or soft, &c.

We are able to trace in many ways the influence of nerve-force in maintaining the vitality of a part. Suppose a child to have a deformity of a limb, dependent upon abnormal position of the bones, as in club-foot; that limb will attain the same length and admit of development to the same extent as the opposite. Suppose, on the other hand, that the affected limb be suffering from infantile paralysis, referable to change in the great nervous centres, it will be noticed that there is a want of animal heat, a sluggish circulation, defective nutrition, and arrest of growth. A limb so conditioned, when exposed to cold, or otherwise injured, is but little able to maintain the processes proper to repair; and although, in many cases of loss of nerve-power, death of the tissues seems to result from their inability to bear ordinary inflammatory disturbance, still there are other cases in which the rapidity of the change from life to death requires another explanation. Such a case, probably, is that related by Sir B. Brodie, who saw mortification of the ankle begin within twenty-four hours after an injury to the spine. But diminution of nerve-power generally leads to impairment of nutrition, and to repeated attacks of low inflammation, during which the tissues may slowly perish. A warder in the Bridewell city prison suffered for many months from agonising pain in the head; at times he had scarcely command of himself; the pain chiefly seemed to follow the course of the branches of the right superior maxillary nerve, but the other branches of the fifth nerve of the right side were likewise affected. In course of time the cornea of the right eye became opaque, and the conjunctiva red. After some weeks the cornea sloughed, and the humours of the eye escaping, the organ collapsed. The termination of the case was singular. One night, after agonising pain in the head, something was felt to burst, when a large quantity of thick matter was discharged from the nose; the symptoms subsided, the man regained his usual health, and passed into some other avocation. In the Museum of St. Bartholomew's Hospital (ser. ix. no. 9) is an example of central penetrating ulceration of the cornea, in consequence of destruction of the trunk of the fifth cerebral nerve by the pressure of a tumour near the pons Varolii. The whole nutrition of the corresponding side of the face was impaired; the patient had repeated attacks of erysipelatous inflammation, bleeding from the nose, and at length destructive inflammation of the tunics of the eye, and this ulceration of the cornea.

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* *Gulstonian Lectures*, in *Medical Gazette*, 1847.

Parts may die through a deficient supply of blood, and this may be the sole cause, as when mortification follows the application of a ligature to the main artery of a limb, or the sudden laceration of the same vessel by violence; or it may be combined with diminished nerve-power, as in some cases of gangræna senilis. When death of a part takes place rapidly, the vessels still contain blood and the usual fluids, and the mortified parts are moist and soft. When, on the other hand, the death is slower, there is usually a deficiency of supply of blood; the vessels become empty, and the part hardens and withers. And hence we read of moist or acute, and of dry or chronic gangrene. Exceptions to this law are apparent and not real. When it was remarked by Mr. James, "that acute or rapid mortifications are not necessarily humid, as the slough from the application of caustic potash proves,"* he should have added that the caustic action of this application consists in the abstraction of the watery elements of the part on which it acts.

Death speedily follows the complete stagnation of blood, as when a part is firmly strangulated. But if there be any circulation, however imperfect or slow, nature struggles for life. The surgeon who undertakes to destroy a vascular nævus, or mother-spot, by the ligature knows well the importance of using a stout thread and of tying the knot firmly. No half-measures will answer; either the circulation is completely arrested, or the operation is only partially successful. The same effect may be noticed in cases of strangulated hernia; if the strangulation be complete, the part dies at once; but if it be less in degree, the venous circulation is retarded, while the arterial goes on; hence congestion and swelling ensue; inflammation may supervene, or ulceration at the seat of the stricture. It may be questioned, however, whether vitality becomes extinct in any case of this kind until the strangulation is so firm, either directly or from secondary swelling, that complete stagnation of the blood has taken place. I have seen mortification of the whole of a lowly-organised morbid growth in the thigh follow an operation undertaken without success for its extirpation; but here, doubtless, the tumour had been displaced from its connexions during the proceedings of the operation, and it perished accordingly. Such cases are rare.

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* *On Inflammation*, p. 94.

It is commonly believed, however, that inflammatory congestion is that which most commonly leads to mortification; but in accepting this view we must couple with it a modification, which Mr. Paget thus expresses: "It is perhaps to be regretted that the cases of this class should have been taken as if they were the simplest types of the process of mortification, and that the process should have been studied as an appendage, a so-called termination of inflammation; for, in truth, the death of an inflamed part is a very complex matter; and, in certain examples of it, all the more simple causes of mortification may be involved. Thus inflammatory congestion may end in the stagnation of the blood, and this, as an indirect cause of mortification, may lead to the death of the blood, and that of the tissues that need moving blood for their support. But a degeneration of the proper textures is a constant part of the inflammatory process; and this degeneration may itself proceed to death, while it is concurrent with defects in the condition of nutrition."* The formation of bed-sores is referred by the same author to the second of these conditions, for he points out that the intensity of an inflammation is not alone a measure of the probability of mortification ensuing in its course; neither is mere debility, for we daily see inflammation without death of parts in the feeblest patient with phthisis and other diseases. "It is as if the death of the part were the consequence of the defective nutrition, which concurs with the rest of the inflammatory process, being superadded to that previously existing in the part."*

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* *Surg. Pathol.* vol. i. p. 459.

Instances of mortification from defective nutrition are illustrated by the examples of sloughing of the cornea in animals fed upon food deficient in nitrogen. And the influence of improper food upon the blood, rendering it unfit to maintain vitality in the remoter parts of the body, is exemplified by the accounts of gangrene affecting the lower extremities in persons eating bread made of bad black wheat or rye. This occurrence has been known to prevail in districts on the Continent, especially after wet seasons, where rye forms a principal article of food. The name applied to the diseased rye is ergot or cockspur rye. The part of the body affected seemed to become insensible, cold, dry, and withered; to undergo those changes to which the term dry gangrene has been applied. Saviard mentions that, in cases noticed at Orleans in 1694, both upper and lower extremities were affected. Noel, who wrote in 1710, states that he had never seen any one of the female sex affected, and that he had only witnessed one case in which the gangrene attacked the upper extremities. According to Bassau, surgeon to the Hospital St. Antoine, Dauphiny, the cases which he saw were not all of the dry kind, the limb sometimes becoming putrid, and maggots being generated.

Cases of mortification from eating unsound wheat have been recorded by Dr. C. Woolaston in the *Philosophical Transactions*, 1762. But of late years such cases appear to have been rare. The increased facilities of locomotion have proved the means of equalising in some measure the wants and supplies of mankind, and have tended, by raising the position of the very poor, to improve the general sanitary condition.

Among other instances of mortification from defective nutrition is that peculiar affection called Noma, or water-cancer of children; *Wasserkrebs*, water-canker, *cancer aquaticus*. It has been chiefly described by foreign writers, as Galen, Celsus, Battus a Dutchman, who mentions the particulars of the case of a girl, aged five years, who died, and of a boy, aged three years, who recovered. Van Swieten says that he has seen the first set of teeth fall out, and the second set destroyed, the lower jaw-bone exfoliate, the lips, cheeks, tongue, and chin eaten away before the child died. The disease rarely attacks children older than ten or eleven, and younger than one year; and occurs in those of weak frame, improperly and insufficiently nourished. It has been noticed after measles, intermittent, remittent, and other forms of fever. The first symptoms are those of constitutional disturbance, wasting and loss of appetite, followed by swelling of the salivary glands, and a profuse discharge of saliva, which is thin, watery, and fœtid, and flows from the mouth involuntarily during sleep. Next, ulceration commences in the gums, which swell, become livid, and separate from the teeth; these become loose, and are soon covered with dirty sordes. Soon, ash-coloured spots show themselves on the gums and neighbouring mucous membrane; they turn to dark-coloured sloughy-looking sores, which spread rapidly in every direction, exposing the bone, which subsequently exfoliates. The sore spreads from within outwards, not by ulceration, but by a moist and sometimes dry gangrene, while the parts around swell and become first of livid red hue, then of grayish or black colour, marking the spreading gangrene. A large aperture is thus made in the cheek, sometimes separated by a frænum from the mouth, at other times continuous with it.

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* Op. cit. p. 460.

In other cases the tumefaction of the cheek may be shining and hard, resisting the pressure of the finger; the temperature may be increased, and the colour a rose-red fading away at the circumference. After a few days a blue spot appears externally, surrounded by a well-defined red border; the colour next changes from blue to black; and the destructive process goes on with such rapidity that in from three to six days the entire cheek has been destroyed. The changes in the bones seem to be peculiar; they are usually confined to the surface lying next to the layer of softened tissues; the part not in immediate contact being healthy. Two different morbid processes have been noticed. First, the separation of the alveolar process from the portion of diseased bone; secondly, the successive destruction of the remaining surfaces of the bone. The organised constituents take part in the process of softening, the earthy particles being set free; thus in children the separation of the alveolar process is easily effected, while the rest of the bone acquires a more or less worm-eaten appearance when the destructive process goes more deeply. An examination after death shows the sphacelated part of doughy consistence, black and easily torn. Underneath the external gangrenous covering the areolar tissue is greasy and yellow; serous infiltration, also of yellowish colour, has taken place around. There is effusion under the arachnoid membrane and in the ventricles of the brain. In one case the heart and lungs were bloodless, and there were tubercles in the substance of the latter. The intestines were adherent, from the effects of previous peritonitis, and the mesenteric glands were swollen. In such a disease the obvious indications are, to remove the patient to pure air, to administer stimulants and proper nourishing diet, and to touch the sloughing parts with a solution of nitrate of silver, or some other stimulating application. There may be cases requiring the use of a strong escharotic.

We have now to speak of the mode by which, after the cessation of the gangrene, the dead are separated from the living parts. It is but seldom that this process is attended by hæmorrhage, for the blood coagulates in the large arteries which lead to a mortified part. When a gangrened limb, observed Petit, is cut off in the dead part, no hæmorrhage occurs, because the blood is coagulated a great way in the vessels. . . . . We have several examples of limbs amputated on account of gangrene, in which no hæmorrhage occurred, although the amputation was made a considerable way in the living parts; because the clot was not confined in these cases to the dead part, but was continued forwards into the living as far as the inflammatory disposition extended.* When gangrene stops, the livid colour of the adjacent integument, which marks its onward progress, becomes brighter and redder. It is at this part where the so-called ulcerative process begins, constituting the line of demarcation between the dead and living parts. It was at one time believed that this was accomplished by the ulceration of the portions of the living tissues which are immediately contiguous to the dead; and that the groove, gradually becoming deeper, undermined the mortified parts until they were completely separated. In proportion as the groove deepens, so do granulations rise from the living surface, and pushing, as it were, the slough before them, present upon its removal the aspect of a healthy granulating sore. But in this explanation the ulcerating and granulating processes would seem to proceed at one and the same moment, which is impossible; and perhaps the latter process is of earlier occurrence, and of greater importance in the act of separation, than is commonly believed. The possibility of the living tissues acting by absorption on the dead, at one time disbelieved, has now been proved by cases of the absorption of portions of pegs of ivory, driven like nails into bones, to excite inflammation, for the repair of ununited fracture. Such a case occurred under the care of Mr. Stanley, some years ago, and more recently in one treated by myself, where, so active was the absorption, the patient being a child, that the pegs dropped out before accomplishing their end, being deprived, as it were, of their fangs. The fact of the upper portion of the peg being untouched, though in contact with the living tissues and imbedded in pus, may be due to a law that the absorbents of bone are required to act upon the osseous tissue. Certain it is that the granulating process seems to be contemporary with the separation of the living from the dead tissues. The superficial slough, formed by the application of strong nitric acid, affords us the opportunity of witnessing this process. When the treatment is employed for stopping spreading gangrene with success, the first local effect after the charring of the sloughing surface, is the disappearance of the livid red colour of the yet living skin; then, in the course of a few days, the dried slough shrinks and contracts, while from the line between it and the living parts granulations seem to spring in every quarter; and just in proportion to the rapidity of this process of separation, are the granulations the more abundant and the secretion of pus copious.

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* *Mém. de l'Acad. des Sciences*, 1732.

For the phenomena attending exfoliation of bone see DISEASES OF BONE.

When soft parts are about to mortify, the bright red and shining condition of the skin, previously existing, becomes of deeper and more livid hue; and here and there patches of dusky brown, green, or blue, mottle the surface. The cuticle becomes loosened, and rises in blisters; the temperature falls; and the discoloured parts become cold and insensible. The colour of the skin becomes deeper and blacker, a thin stinking fluid issues from the exposed integuments, and gas is evolved from the decomposition of fluids in the deeper-seated structures.

If a limb which has undergone this change be cut into, the deeper-seated tissues are found to be soft, putrid, and rotten. They are soaked in a thin fœtid serum, mixed with bubbles of gas. The colour varies from ash-colour to brown, but rarely black. The tendons retain much of their normal appearance, except that when handled they are found to be softer than natural.

The appearances presented by mortified intestine, as observed in the operation for strangulated hernia, differ but slightly from the above. The surface of the gut loses its smooth bright aspect, although the vessels remain congested and the part is black. But on this black surface the death of the tissues is marked by ash-coloured spots of various shapes and sizes, which in some instances map-out the surface of the congested intestine. The same thin stinking fluid exudes, and frequently fills the hernial sac; while the effects of this change are indicated externally by the deeper and more livid colour of the skin, and its yielding and doughy feel to the touch.

The treatment of mortification is guided by rules which are much simpler than in times gone by. It is true that the surgeon will have to consider whether the form of the disease be acute or chronic, and whether the patient be suffering from pain, fever, and constitutional disturbance; but upon one point he may be sure in every case, namely, that he will have to husband the patient's strength and to soothe him in all possible ways. The idea of the surgeon "seeking to afford relief by imposing the antiphlogistic regimen," which consists in the employment of "blood-letting, purgatives, diaphoretics, and diluents,"* is now regarded as preposterous; and cases are not met with in which "after one bleeding the pulse is quick, hard, and full." Sir Astley Cooper seems to have understood the impropriety of abstracting blood in cases of gangrene, although in courtesy to his provincial brethren he limited his condemnation to London practice. His plan consisted in giving small mercurial doses at night, in order to restore the secretions of the intestinal canal and liver; and the liquor ammoniæ acetatis with a few drops of the tinctura opii, several times a day, with the view of lessening irritability and tranquillising the system. We may often read an instructive lesson from transitions of opinion. The practice of bleeding, founded on improper principles, was tacitly condemned; and no other course substituted except an attempt to palliate symptoms.

In 1715, Mr. Rushworth, a surgeon of Northampton, published his remarks on the value of Peruvian bark; and the most exaggerated statements of its efficacy were made by its supporters, who affirmed, with a want of judgment equal to that of the supporters of venesection, that it ought to be employed in almost all cases of mortification, as soon as the violence of the inflammatory symptoms has been appeased.

More accurate pathological investigation has taught us that, in truth, the means which we possess of controlling gangrene are few in number, although they often require great discrimination in their use. We should never lose sight of the cause of the disease. In an instance related further on, where mortification of the lower extremities resulted from impairment of the heart's action caused by effusion of fluid into the pericardium, the administration of mercurials tended, by suppressing inflammation, to remove the offending cause. When a part has perished in consequence of cold and starvation, warmth and generous diet, administered with prudence, is the course clearly indicated. There are instances in which bark or quinine may be indicated in preference to wine or other stimulants; but in no way do we possess a specific against mortification, either as an external or internal remedy.

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* Thompson on *Inflammation*, p. 559.

Of all medicines which need special notice, opium stands preeminent. By its free administration we are enabled to control in some degree the pain which wears out and exhausts the patient. Mr. Pott used to administer one grain every three or four hours; but never less than three or four grains in the twenty-four hours. He recommended it, not as a specific, but, in Hunter's words, as "a remedy which does good by not letting the disease do harm to the constitution."

The following, then, should be the plan of treatment: If there be heat of skin, combined with feverish symptoms,—thirst, loss of appetite, sickness, and rapid pulse,—let us remember that this stage will soon pass by and leave the patient in need of all his remaining strength. Let not the surgeon *force* solid food upon the patient against his will; easily-digestible food, such as milk, puddings, broth, &c., may be freely offered; port-wine and water, or brandy and soda-water, or effervescing salines, may be prepared as drinks. If ice be grateful to the palate, there is no objection to its employment. Pain must be controlled by opium or morphine.

In cases where there is absence of fever, preparations of bark may be given; and of these perhaps the liquor cinchonæ is the best. It may be combined with ammonia, aromatics, chloric æther, camphor, or other similar preparations.

In speaking of local applications, we cannot do better than call to mind the words of Mr. Pott: "Whatever heats, irritates, stimulates, or gives uneasiness, appears to me always to increase the disorder, and to add to the rapidity of its progress. And, on the contrary, I have always found that whatever tended merely to calm, to appease, and to relax, at least retarded the mischief, if it did no more." It is desirable to keep the living parts warm; consequently the limb may be wrapped in cotton-wool or flannel. If the mortified part is dry, no particular local application is needed; but wherever it is moist or emits an unpleasant odour, it may be enveloped in a charcoal-poultice, made by mixing powdered charcoal and linseed-meal; or be surrounded by muslin bags filled with finely-broken wood-charcoal. Stimulating applications, such as brandy, balsams, or resins, are usually worse than useless.

On this head exception is made to the treatment of cases of traumatic gangrene, where immediate amputation, when possible, is indicated; to hospital gangrene, which is treated by the application of powerful escharotics; and to frostbite; on each of which subjects the treatment is appended to the proper section.

Traumatic gangrene. A part may be destroyed by direct local violence. There is no preceding inflammation, nor vascular disturbance of any kind, to account for the change; the immediate effect of the injury has been to deprive the living tissues of their life, when they become subject to the same laws of decomposition as are applicable to the dead animal. As occurring in the lower extremity, the foot becomes cold and pulseless; there is no sensation, even if the part be pricked with a needle or knife; the appearance of the limb may not be much changed, for the skin is elastic and does not lacerate very easily. In 1835, a brewer's servant was riding asleep on the shaft of a dray drawn by a powerful team of horses. In passing through a turnpike the man's legs were jammed between the dray and the gatepost: the patient was immediately brought to the hospital. The right leg was severely injured; but the left was simply cold and without sensation: vitality had left it; and after amputation it was found that, although the integument was entire, every tissue had been crushed and divided down to the bone, the popliteal nerve alone retaining its continuity. The same species of accident is that inflicted by cannon-balls or other heavy missiles, by steam-machinery or railway contusions: the part perishes simply because unable to retain the life inherent in it. The cause of death is not from want of blood. Vitality would be equally extinct, were it possible to maintain the circulation artificially.

But the proximity of a mortified part to living tissues cannot be borne with impunity. Nature endeavours to cast off the dead from the living tissues by an inflammatory process in the latter, which speedily lose their vitality from inability to support this action towards repair. According to Hunter, a diminution of power, when joined to an increased action, becomes a cause of mortification, by destroying the balance which ought to subsist between the power and action of every part. Thus the mortification spreads towards the trunk preceded by a blush of dusky red, marking its onward course and illustrating what is called "traumatic gangrene."

It does not often happen that the surgeon witnesses in such cases death from the unchecked progress of the disease. The indications for immediate amputation are so clear and so generally acknowledged, that he who shrinks from the responsibilities of the operation stands exposed to just reproof. A girl once came before my observation in whom the left arm had been crushed by machinery beyond the possibility of repair. Partly yielding to the patient's own strongly-expressed wishes, the surgeon did not amputate: mortification took place within a few hours; it spread upwards towards the chest, the tissues about which became infiltrated and swollen by serous exudation, and the patient expired comatose after sufferings of no ordinary character, during which she frequently implored the performance of that operation which, once delayed, was no longer practicable. In the case of a bone, there may be no apparent change of tissue—the part which is dead remains surrounded, and even attached to living tissues; but its circulation cannot be restored; and its removal by absorption, at one time thought impossible, is at least so slow a process, as rarely to be contemplated by the surgeon in the light of a curative action.

The application of powerful escharotics produces, in the same way as the application of heat, immediate death of a part by chemical decomposition. No inflammatory process is needed to account for the change, the heat and redness which may be noticed in the surrounding tissues being connected with the process of separation of the slough. Let us select as an illustration the action of strong nitric acid upon the living tissues. This escharotic applied to any part of the living body causes immediate decomposition of the different elements, which become oxidised, leaving the carbon of the tissues as an eschar. Experience has shown that, after a part has been thus purposely destroyed, the better mode of treatment consists in leaving the dry eschar exposed to the air, the watery parts having been removed by the acid.

Immediate death of a part may be produced by the extremes of heat and cold; and although it is commonly believed, and may in some instances be the case, that these agents, as well as caustics, applied in smaller measure do not kill the part at once, but excite an inflammation in it, which, added to the damage already received, may lead to indirect or secondary mortification, yet when we try to accomplish this end in practice as a means of cure, we encounter unforeseen difficulty. The injection of nævi, or mother-spots, with irritating fluids is an example of what has just been said. I know of no means by which a sufficient amount of inflammation so as to cause death of the part can with certainty be produced; we may destroy the vascular system at once by a powerful caustic, but we cannot always induce secondary mortification. Freezing applications, employed to render a part insensible to the pain of a surgical operation, are not followed by secondary inflammation and mortification, nor has a similar result ensued from the exposure of the body to heat. It is more than probable that, in the healthy subject, the vitality of the different tissues is in little danger from inflammatory disturbance. The death of a part must be effected by powerful agencies coming from without, or by some accidental causes of disturbance to the general health. The only apparent exception to this is in the case of sloughing of tendons or areolar tissue after certain forms of inflammation; but the peculiar character of organisation in such structures is a sufficient explanation of this occurrence.

Secondary mortification. It is difficult in all cases to draw the line between immediate and secondary mortification. A boy was under the care of Mr. Lawrence in St. Bartholomew's Hospital, to whom mortification of the toes had ensued from his sitting with his feet in the water of a running stream one summer's day after a long walk. We cannot believe that this accident could have happened to a perfectly strong and healthy child; there must have been some cause to render the circulation feeble and the extremities cold. In all probability, the blood never flowed again in its accustomed way through the chilled parts; and the inflammation which surrounded the mortifying structure was, it is true, due to vascular reaction in living tissues, but in no way connected with the spread of the gangrene, the exact extent of which was limited by the accident. In other instances we see a patient of habitually intemperate habits suffering from gangrene of an entire limb; the integument is of livid red colour, the countenance sunken and anxious, the pulse rapid and feeble. At one time we accepted the explanation of such cases, that inflammation occurring in a part of low vitality was likely to be followed by gangrene; but more accurate pathological investigation has shown that the main artery of the limb may be plugged,* and that causes, either mechanical or vital, may interfere with the establishment of the collateral circulation. Although it is true that the progress of the mortification is marked by low inflammatory action, yet it would be incorrect to regard such inflammation as the cause of death. The part is perishing from insufficient supply of blood; and the vascular excitement, the last expiring flame of vitality, does but influence the course which in each case the peculiar method of disorganisation may take.

Gangrene consequent upon a low type of inflammation requires for its development the exercise of some of those subtle undefined causes which govern the outbreak of epidemics. We apply to it the terms, phagedæna gangrænosa, gangræna contagiosa, hospital gangrene, sloughing phagedæna, &c. It is a species of humid gangrene, peculiarly characterised by its contagious and infectious nature. During an outbreak which took place in the year 1846 in St. Bartholomew's Hospital, the extension of the disease in two instances was clearly traced to the use of a sponge which had been first applied to a gangrenous sore, then boiled, and afterwards applied to a healthy wound. The infectious nature of the disease—that is to say, its rapid extension from patient to patient without personal contact in the same room—has been often witnessed. By this term we mean not only to imply that a number of persons living in the same room, breathing the same atmosphere, and exposed to the same causes, suffer in common, but that the exhalation from the wound of a person suffering from hospital gangrene may become in itself the means of the spread of the disease. A lady living in a low but not unhealthy part of the environs of London underwent the operation of extirpation of the breast for cancer. She was of excitable temperament, but healthy-looking and country-bred. About ten days after the operation, the wound assumed an unhealthy aspect, and became gangrenous in the space of twenty-four hours. She was restless and irritable, although the pain was not insupportable. A single application of the strong nitric acid sufficed to arrest the sloughing process, and the patient recovered. But the odour clung to the walls of the chamber; and after her removal, and the apparent purification of the apartment, of two persons who consecutively slept there for a night, the first had a sharp feverish attack, attended with total loss of appetite; the second had a sudden attack of diarrhœa. There is every reason to believe that had a patient with an open wound been put there, the healing process would have been arrested.

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* For further information on this subject see DISEASES OF ARTERIES.

In contrasting the experience gained in the Peninsular with that obtained during the Crimean war, one cannot fail to be struck with the remarkable rarity of gangrene among the British hospitals in the East. "During the first winter," says Mr. Macleod, "it prevailed a good deal in a mild form at Scutari; but it never became either general or severe. It frequently attacked the openings both of entrance and exit (as applied to gunshot wounds); but occasionally seized on one only, showing apparently a predilection for the wound of exit."* Dr. Taylor thought that in India gangrene more commonly appeared in the wounds occasioned by grape or canister. In many cases Mr.

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* *Surgery of the Crimean War*, p. 165.

Macleod thought the best designation would have been putrid degeneration. "The abominable state in which the barrack-hospital at Scutari was during its early occupation may well have caused an outbreak of hospital gangrene among the broken-down men, who lay so thickly around the doors of the offensive latrines; but I cannot say that I noticed any greater tendency to its appearance at these places than at any other portion of the hospital. The corridors presented, I think, the greatest number of cases. Whenever it appeared, the patients were isolated, and sent into wards set apart for the treatment of the disease."* The French, however, suffered most dreadfully from hospital gangrene in its worst form; the great evil appearing to have been "overcrowding." The disease raged rampant in the hospitals on the Bosphorus, and likewise in many of the transports. M. Lallour, surgeon to the Euphrate, says, in his paper on the subject, that from one of their ships sixty bodies were thrown overboard during the passage of thirty-eight hours to the Bosphorus.

There cannot be a doubt, in speaking of the causes which lead to this fearful disease (which rages under certain circumstances thus endemically), that it is due to the agency of some unknown poison, which finds for itself a soil fit for propagation. Some circumstances, such as overcrowding and bad drainage, promote its rapid increase; but they alone are insufficient to account for all the phenomena. In the winter of 1846-47, the buildings constituting the north side of the square of St. Bartholomew's Hospital became invaded by the malady now under consideration. A healthy man, aged 32, cut his hand in the palm by accident, December 2. He was put into a light and airy ward, in the next bed to a patient suffering from compound luxation of the radius, attended with symptoms of diffuse inflammation of the areolar tissue. The cut hand swelled, became hot and painful, and a small abscess formed, which was opened by the house-surgeon. The wound thus made sloughed and assumed some of the characters of a phagedænic venereal sore. The man was immediately removed to another part of the hospital, and, after considerable loss of substance, including some of the tendons, the hand ultimately cicatrised, but with impairment of motion. The patient with the dislocated wrist, suffering from diffuse cellular inflammation, died on the 23d of December; and it was found on examination after death, that suppuration attended with sloughing of the tendinous structures existed in both fore-arms, extending among the muscles under the fascia to near the elbow-joint. From this time a succession of cases of well-marked hospital gangrene ensued, the particulars of which, read before the Medico-Chirurgical Society, are recorded in the *Lancet*, 1857. It was argued, from the circumstances attending a similar outbreak in University College Hospital, that the disease was apt to occur in new buildings, that in which it was first noticed at St. Bartholomew's Hospital being quite of recent date. But in opposition to this view, there were at the same time cases in one of the older parts of the hospital quite detached from the preceding, but presenting the same aspect to the north. Now in that year there had been striking thermometrical changes from unseasonable heat to extreme cold, and it is remarkable that when the disease prevailed in the Crimea there blew that much-dreaded wind, the oppressive sirocco. "In the Crimea," says Mr. Macleod, "during the heat of the summer of 1855, after the taking of the Quarries, and the assault on the great Redan in June, not a few amputations of the thigh were lost from moist gangrene of a most rapid and fatal form. In the case of a few, who lived long enough for the full development of the disease, gangrene in its most marked features became established; but most of the men expired previous to any sphacelus of the parts, overwhelmed by the violent poison which seemed to pervade and destroy the whole economy. This form of the disease occurred in four cases under my own charge, in men who had had a limb utterly destroyed by round shot or grape. In all, the knee-joints were crushed; the collapse was deep and prolonged; and the operation performed primarily in the middle third of the thigh. Three of the four were of very intemperate habits. All these cases took place about the same time, at Midsummer, when many other similar cases appeared in camp. The wards, though full, were not overcrowded, and could from their construction be freely ventilated. The weather was sultry, and the cholera was in camp. The atmosphere was charged with electricity, and the dreaded sirocco prevailed. Wounds generally assumed an unhealthy aspect for days when this pestilential wind blew. The cases of all those who died in my wards seemed to be doing perfectly well up to sixteen hours, at the furthest, before death."*

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* Op. cit. p. 166.

The statement of Mr. Blackadder,† that hospital gangrene is at first a purely local affection, and that the constitutional symptoms do not make their appearance before the third or fourth, sometimes not till the twentieth day, is quite at variance with present experience. In St. Bartholomew's Hospital patients complained of pain and tightness across the forehead, accompanied with severe headache; the pulse was small, quick, and thready; the aspect of the countenance anxious and depressed; and they were very commonly irritable. There was from the first a stinging pain in the wound, which prevented sleep. So constant were these symptoms that the surgeon could predicate the outbreak of the disease in particular cases. Now what says Mr. Macleod? "In recording one case I relate all. During the night previous to death, the patient was restless, but did not complain of any particular uneasiness. At the morning visit, the expression seemed unaccountably anxious, and the pulse was slightly raised. The skin was moist and the tongue clean. By this time the stump felt, as the patient expressed it, heavy like lead, and a burning stinging pain had begun to shoot through it. On removing the dressings, the stump was found slightly swollen and hard, and the discharge had become thin, gleety, coloured with blood, and having masses like gruel occasionally mixed with it. A few hours afterwards the limb would be greatly swollen, the skin tense and white and marked along its edge by prominent blue veins. The cut edges of the stump looked like pork. Acute pain was felt."* Mr. Macleod here says, "the constitution by this time had begun to sympathise." Surely he has shown by his own words a sufficient amount already of serious general disturbance. The cold sweat which broke out over the body; the irritable stomach; and the weak, frequent, and failing pulse, were but indications of approaching dissolution. The respiration became short and hurried, giving evidence of the great oppression of which the patient so much complained. The heart's action gradually and surely got weaker, till, from fourteen to sixteen hours from the first bad symptom, death relieved his sufferings. Post-mortem examination, instituted shortly after death, showed the tissues of the limbs, and in many cases those of the internal organs also, to be filled with gas and loaded with serous fluid. The vessels leading from the stump were healthy, and in only one case had there been any actual mortification previous to death. After the taking of Sebastopol in September, the same form of disease again appeared, especially among the Russians who had been operated on, and was so deadly, that "in no case, which I could hear of, did recovery follow."† Dr. Hennen's account of hospital gangrene as it occurred in the Peninsula, during the war with the French, corresponds in all essential particulars with the above. "Let us suppose that our wounded have all been going on well for several days, when suddenly one of our most promising patients complains of severe pain in his head and eyes, a particular tightness about the forehead, loss of sleep, and want of appetite; and that these feelings are accompanied with quickness of pulse and other symptoms of fever; his wound, which had been healthy and granulating, at once becomes tumid, dry, and painful, losing its florid colour, and assuming a dry and glossy coat. This is a description of the first stage of our Bilbao hospital gangrene. If this incipient stage were overlooked, the febrile symptoms soon became aggravated; the skin around the sore assumed a higher florid colour, which shortly became darker, then bluish, and at last black, with a disposition to vesicate, whilst the rest of the limb betrayed a tendency to œdema. All these threatening appearances occurred within twenty-four hours; and at this period the wound, whatever might have been its original shape, soon assumed the circular form. The sore now acquired hard, prominent, rugged edges, giving it a cup-like appearance, with particular points of the lip of a dirt-yellow hue; while the bottom of the cavity was lined with a flabby blackish slough. The discharge in this second stage became dark-coloured and fœtid, and the pain extremely poignant."*

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* *Surgery of the Crimean War*, p. 168.

† *Observations on Phagedæna gangrænosa*, by H. Home Blackadder; 1818.

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* Op. cit. p. 170.

† Op. cit. p. 171.

There is no reason to believe that the disease, as witnessed now, differs in any essential particulars from that recorded by the surgeons of the Peninsular war; and a careful examination of facts shows, I think, conclusively that the causes which lead to its outbreak are general and not local, and in most instances preventable. A case came before my observation in which spreading gangrene of the character here described took place on the nates of a young married woman. She had been travelling outside a coach, and had got wet and excoriated, and she attributed the disease to this accident. But then one knew nothing of her habits or place of abode, and it may be inferred that she told as much of her history as she found convenient. Cases are not uncommon in which gangrene attacks one sore, leaving others on the same subject in their usual state; and this fact has been urged as an argument in favour of the disease being primarily local. But in the course of a short time the same change will be observed, if the conditions remain unaltered, to spread from part to part, and that too in spite of the most rigorous attention to cleanliness.

The treatment of hospital gangrene consists, firstly, in the entire destruction of the sloughing surface by the strongest procurable escharotic. Nitric acid is generally preferred. It should be applied by means of a small mop made of lint wound round a piece of wood of sufficient strength to admit of being pressed into every part of the wound. The eschar thus formed should be allowed to dry and form a hard and charred layer, under which granulation advances with great rapidity. No poultice or wet lint is needed; and there is no need of hurry in separating the eschar from the parts beneath. Chloroform should be administered, as the proceeding is very painful; then a full dose of opium should be given, and repeated if necessary. A liberal allowance of wine, spirits, and other stimulants must be ordered, for patients take large quantities during this state of depression with impunity. Bark and quinine in these cases are frequently useful, and I have given the latter in large doses with success in cases where the application of the acid has failed. Should the sloughing process go on under the eschar, and the repetition of the caustic be impossible or injudicious, the Peruvian balsam may be laid on freely, while the greatest attention is paid to keeping every part of the surface as dry as possible.

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* *Principles of Military Surgery*, by John Hennen, M.D.

But local treatment will frequently prove unavailing, so long as the patient remains exposed to the same influences. He should be removed from the ward or sick-room, and put into another building; and when such a measure is impossible, the ventilation should be as free as possible, the windows being left open day and night, while disinfectants should be liberally spread about. No sponges should be allowed; or, after having been used, they should be immediately burnt. Dressings and applications of all kinds should be similarly destroyed when of no further use. And, finally, the surgeon should feel that it were better for the sick to be unsheltered in the open plain, than to continue in the crowded wards of an hospital so affected.

The effect of cold in producing frostbite was seen upon a large scale during the war in the Crimea by the surgeons attached to the British and French armies; and there was a peculiar form of the disease affecting the hands and feet, very common during the first winter and spring, which Dr. Tholozan and some of the French surgeons were inclined to look upon as allied to a peculiar disease which appeared epidemically in France between the years 1828 and 1832, and was then termed acrodynia. Mr. Macleod, however, and with him, I believe, most English surgeons, is persuaded that it was the joint product of cold and scurvy. "This affection," he says, "showed itself chiefly in the pulpy parts of the feet and hands, but especially in the ball of the toes, in the edges of the feet, and in the muscular ridge which runs across the sole of the foot at the roots of the toes. Its earliest symptom was a prickly sensation experienced when the patient stood on the foot, and was variously described by them as resembling the pricking of pins, or as if they walked on nails. There were lancinating pains in the calves of the legs, which parts felt hard and brawny, and were sometimes swollen and discoloured. There was weariness in the limbs, and a most distressing heat in the feet, especially at night, when the weight of the bedclothes could not be borne. An erythematous redness was often observed along the edges of the feet or hands; and the sensibility, though generally heightened, was occasionally diminished, so that they sometimes said, in walking "they did not feel the ground." It was often localised in small patches, and not always accompanied by other scorbutic symptoms. It was often combined, too, with low fever or dysentery, and not unfrequently followed by desquamation of the epidermis, and sometimes by local gangrene.*

This affection was intractable so long as the depressing influences on the general health continued; and it was remarked that during the first winter the frostbites were much more severe and difficult to manage than during the second, when better preparations were made for the occupying forces. The French suffered more than the English. "In their hospitals," says Mr. Macleod, "a limb might be seen sphacelated half-way to the knee."

Any wounds from frostbite are peculiarly difficult to heal; and "the removal of bone from the fingers or toes, however black and apparently dead, and though only attached by the most slender connexion, was certain to cause a great amount of irritation, which sometimes became alarming."† The same was noticed wherever the patient was situated, whether in the hospitals, in the camp before the city, on the heights above Balaclava, or in the warmer regions of Scutari, Renkioi, or Smyrna. Surgeons gave up interfering in any way. The most soothing applications; the greatest gentleness; rest in the horizontal posture; the administration of generous diet and stimulants in proper quantities, were the chief measures found of service. It mattered not whether or no chloroform were administered; a surgical operation to divide even the smallest band was found to be fraught with danger; and special injunctions for non-interference in any way were therefore very properly impressed on the younger surgeons. We have in the Museum of St. Bartholomew's Hospital the feet of a girl aged nineteen which became frostbitten during a cold night when she slept in the street. An attempt was made to restore circulation by putting the feet into warm water.

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* *Surgery of the Crimean War*, p. 79.

† Op. cit. p. 173.

Senile gangrene presents itself under two forms; the dry and the moist. The former (*gangræna sicca*) is due to the gradual decrease in the supply of blood to the part, and is slow in its progress; the latter, also dependent on deficient supply of blood, is more especially influenced by low inflammatory action consequent on irregularity in the circulation, and diminished nerve-power. In the first, the part slowly withers, and becomes dry. In the second, the part, feebly nourished, becomes inflamed, and perishes. This disease, as its name imports, attacks chiefly the old, or those whose constitutions have been injured by excess. Some surgeons have remarked that great eaters, rather than great drinkers, have suffered from moist gangrene; and as early as the days of Cowper, the ossification of the arteries of the legs was noticed in persons who had died of this disease in both forms.* A patient may be old from excess, and suffer from gangrene of the extremities at a comparatively early age. A man aged fifty-four was admitted into St. Bartholomew's Hospital Feb. 22d, 1839, with mortification of the third and fourth toes of the right foot; œdema of both legs; cough and expectoration of mucus tinged with blood. The countenance was of bluish aspect, as if there were obstruction in some part to the circulation. The extremities were cold, and the pulse feeble and at times scarcely perceptible. The man died the following day, and the body was removed without examination. An instance of gangrene of the foot at a yet earlier age was under the care of Mr. Lawrence in St. Bartholomew's Hospital in 1857. The patient, a young man aged 23, had a severe attack of acute rheumatism, accompanied with pericarditis; effusion took place into the cavity of the serous membrane, and the circulation became so impeded that mortification of the foot ensued. Under proper treatment, the mortified parts separated and the stump of the foot healed; but the patient suffered so much from the imperfect nature of the cicatrix, that he again presented himself for admission, being desirous of having the foot removed by amputation, which operation I performed during Mr. Lawrence's temporary absence. Inasmuch as the causes which produce this form of gangrene may come into operation at different ages, the term "senile" gangrene need not be used. The terms "dry" and "moist" express sufficiently the leading characteristics. Mr. James relates a case in which it happened to a woman aged forty-two.*

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* *Phil. Trans.* vol. xxiii. p. 1195.

There cannot be a doubt that simple diminution of the heart's action will in some cases be followed by mortification of the lower extremities. We see such occurrences after severe fever; but granular degeneration of the contractile coat of the arteries will, by destroying the equalising power of these vessels over the circulation, lead to the same result. The action of the heart, however, is not in itself sufficient to preserve the proper supply of blood to all the tissues of the body; the stream is maintained by the contractility of the arteries, and, as recently shown by Mr. Wharton Jones, by that likewise of the veins. In old persons suffering from this form of gangrene the blood has been found thin and insusceptible of coagulation; and in a case where amputation was performed, difficulty was experienced in preventing secondary hæmorrhage. Thus in cases of senile gangrene many conditions may have been combined to lower the vitality and to render parts prone to mortify from accident, injury, or diseases, which under other circumstances would have been trivial in their results. The morbid change has been well described by Mr. Pott: "In some few instances it makes its appearance with little or no pain; but in the majority of the cases the patients feel great uneasiness through the whole foot and joint of the ankle, particularly in the night, even before these parts show any mark of distemper, or before there is any other than a small discoloured spot on the end of one of the little toes. It generally makes its appearance on the inside, or at the extremity of one of the smaller toes, by a small black or bluish spot; from this spot the cuticle is always found to be detached, and the skin under it to be of a dark-red colour. If the patient has lately cut his nails or corn, it is most frequently, though very unjustly, ascribed to such operation. In some patients it is slow and long in passing from toe to toe, and from thence to the foot and ankle; in others its progress is rapid and horridly painful; it generally begins on the inside of each small toe, before it is visible either on its under or upper part; and when it makes its attack on the foot, the upper part of it first shows its distempered state by tumefaction, change of colour, and sometimes by vesication; but wherever it is, one of the first marks of it is a separation or detachment of the cuticle. Each sex is liable to it; but for one female in whom I have met with it, I think I may say that I have seen it in at least twenty males. I think also that

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* *On Inflammation*, pp. 545-552.

I have much more often found it in the rich and voluptuous than in the labouring poor; more often in great eaters than free drinkers. It frequently happens to persons advanced in life, but it is by no means peculiar to old age. It is not in general preceded or accompanied by apparent distemperature either of the part or of the habit. I do not know any particular kind of constitution which is more liable to it than another; but as far as my observation goes, I think that I have most frequently observed it to attack those who have been subject to flying uncertain pains in their feet, which they have called gouty, and but seldom in those who have been accustomed to have the gout regularly and fairly."

Mr. Pott's belief, that the idea of the disease proceeding from an ossified state of the arteries is a mere conjecture, has been sufficiently answered by the observations of Thomson and Hodgson.

The treatment of senile gangrene must be conducted upon the usual hygienic principles. If we attempt to combat the disease by "throwing in bark," and by overloading the system with all sorts of stimulants and excess of food, we shall produce an increase of the local vascular excitement, which will be immediately followed by spread of the gangrene. I have known patients over-persuaded to take nourishment against their will, but never has the transgression been done with impunity. In cases of humid gangrene, a light farinaceous diet is usually the most fit; and stimulants should be given with caution, port-wine mixed with water being that usually preferred. Opium must be given in doses sufficient to alleviate pain, and should be continued during the day as well as the night. The patient must be kept strictly to bed, the limb kept warm and slightly raised. Finally, let the surgeon beware of interfering with the separation of the slough; nature will accomplish the task best when unaided. Indeed surgical interference of any kind is, as a rule, dangerous.

In cases of dry gangrene unattended by fever, especially in the aged, stimulants and tonics may be administered more freely; and animal food may occasionally be allowed. But even here excess is to be avoided; the pulse must be consulted and the local disease watched. By care and prudence the life of a patient may be prolonged; and though, in general, the disease ultimately gets the mastery, many years may be passed in comparative comfort.

HOLMES COOTE.

ULCERS.

THE chief interest of this subject, from the surgeon's point of view, is in the study of those forms of ulcer which appear in the integuments; and to these, their diagnosis and treatment, the present essay will be almost entirely devoted. But first, the general process of ulceration, though already referred to at page 7 and other parts of the essay on INFLAMMATION, may be briefly considered.

Ulceration is that part or effect of an inflammatory process in which the materials of inflamed tissues, liquefied or degenerate, are cast off, in solution or very minute particles, from free surfaces, or, more rarely, are absorbed from the substance of the body. Not every such process of casting-off, however, is called ulceration; when the detached particles are only epithelial, though the process may be essentially the same, it is called desquamation, abrasion, or excoriation; and the name of ulcer is not commonly applied to any result of inflammatory casting-off, unless the substance of a tissue deeper than the epithelial be exposed.

Ulceration has very near affinity to gangrene; the two processes, indeed, differ rather in degree than in kind. When the degenerate or dead substance is cast off in one or more portions visible to the naked eye, the process is usually called gangrene, or some synonym of gangrene; when the portions are not so visible, or are quite dissolved, it is called ulceration. Moreover, the separation of a gangrenous or dead part is commonly effected by ulceration of the living, but inflamed and degenerate, part that bounds it; and this separation is, indeed, the best example, and the most frequent beginning, of the formation of an ulcer. If the process be watched that follows the simple killing of a portion of the body (suppose, a piece of skin suddenly crushed or burnt to death), inflammation is seen in all its environs. After some time, the dead part being decomposed and changed according to the merely chemical characters of its materials, the border of the living part next to it is seen in gradual process of removal. Often this border first loses its inflammatory redness, and looks like a pale-yellowish or white zone, or "line of demarcation," round the dead piece or "slough;" but whether this change occur or not, the border of the living part nearest to the dead is first grooved, and then more and more deeply excavated, till the dead piece is wholly separated and detached from the living. The surface from which the dead piece is thus detached is an ulcer; and the explanation of the process is, that the living border, next to the dead piece, being acutely inflamed, degenerates rapidly, is either liquefied or disintegrated, and is thus gradually separated, either in solution or in molecules suspended in the liquid inflammatory exudation.

An essentially similar removal of inflamed structures by ulceration, that is, by solution or molecular disintegration and ejection, may be seen in any spreading ulcer of skin or mucous membrane, of bone or cartilage. Here, there may be no death of visible particles, no sloughs, but the inflamed and rapidly degenerating structures are cast out as by what some have called a molecular gangrene.

It would be needless repetition to describe the minute changes which the degenerating inflamed structures undergo before being cast off; so far as they are known, they are described under INFLAMMATION (pp. 7 sqq.). With them there is always discharged some liquid, in which they are suspended or dissolved. The appearance and properties of this "discharge," or "ichor," are various, according to the causes and characters of the ulcerative process. When the process is very active, the ichor is usually a thin, yellowish or grayish fluid, often tinged with blood, albuminous, not spontaneously coagulable, containing abundant molecular matter, the débris of the ulcerating structures, and corpuscles like ill-formed pus-cells. From some ulcers, *e. g.* the primary syphilitic, it is contagious; from many it appears corrosive, not indeed as having a directly solvent power, but as exciting by its acridity, or by the "catalytic" influence of its own decomposition, inflammatory and degenerative changes in the tissues with which it is in contact. From many ulcers, again, the ichor or discharge is peculiarly "foul," *i. e.* it rapidly decomposes, yielding putrid or other offensive gases, or it contains putrid fragments of the ulcerating structures, or of granulations which die prematurely. Such is, commonly, the character of the discharge from the most rapidly destructive ulcers; while, on the other hand, the more an ulcer tends towards healing, the more does its discharge become like "laudable" pus.

So long as an ulcer is in progress, the tissues next to it are inflamed, and usually are in that state of inflammation which is understood as "low," being marked (at least, in the integuments) by a dusky redness, heat which feels to the patient burning and pungent, and with very little production of organisable matter. Commonly, the ulcerating surface is abrupt, looking jagged, or eroded, dusky, brownish or yellowish, mottled, without granulations, ready to bleed. The more active the progress of an ulcer, the more marked are these characters in the structures round it; and when its progress ceases and healing begins, these characters are exchanged for those of the healthy "determination of blood," which, without inflammation, attends the production and development of reparative granulations.

The healing of an ulcer differs in no material point from that of an open wound with loss of substance. It is a healing by granulations; and though the shape and other characters of the cicatrix often have peculiarities indicative of the disease that it has repaired, there is no known difference in the process of repair (see WOUNDS).

What has now been said of the general process of ulceration is applicable for an explanation of the process by which all or any of the numerous forms of ulcers are produced; we have no knowledge by which to explain the peculiar and characteristic forms that they severally present. Nevertheless, the diagnosis and import of these forms are of high interest in surgery.

The chief forms of ulcers may be best named and arranged, in the first instance, according to the constitutional or specific diseases which they severally indicate or are derived from. For each constitutional disease in which ulcers are apt to occur may be said to express itself in them by the peculiarities of shape, size, and other qualities by which they are severally distinguished from a common ulcer, such as may exist in a healthy person, after the separation of a slough, from accidental violence.

Another nomenclature and arrangement of ulcers, which has been very generally adopted, is derived from characters which they present in certain local or accidental conditions. Thus, ulcers are named irritable, chronic, sloughing, &c. But many of the characters implied by this nomenclature are transitory; many are accidental; some may belong equally to two or more kinds of ulcers that are essentially different and require different modes of treatment.

The plan, then, that will be here followed is that of describing, first, each of the chief varieties of ulcer, distinguished according to their constitutional or specific origin. The type with which to compare and contrast each of them is the simple ulcer, left at the separation of a slough, after injury, in a healthy person; and the type of each distinct form or variety must be in the characters which it presents in its most frequent appearance, or in which it is prone to continue when not disturbed, for either good or harm, by any external circumstance. In a second section will be a description of the subordinate or accidental varieties of appearance which may be found in, or connected with, any of the chief forms of ulcer (though not with equal frequency in all), according to external circumstances.

A common, simple, or healthy ulcer, as already said, is such an one as is left after the separation of an accidental slough in a healthy person. In many of the points wherein other ulcers show some of their chief diagnostic marks, the characters of the simple ulcer are, of course, negative or accidental. Its locality, shape, size, and number, depend on the injury which it has followed. If only the skin has been destroyed, its base is level, slightly depressed (the less so, the more nearly its healing is completed), uniformly covered with small florid granulations, which feel soft, pliant, and elastic, and, though highly vascular, do not readily bleed and are not painfully sensitive. The edges of the common ulcer shelve gently down to its base, and feel scarcely harder than the adjacent healthy skin. At their junction with that skin they are generally opaque-white, with a very slight thickening of epidermis; within this they have a pale purplish-blue tint, where the new-formed epidermis veils the colour of the healing granulations; and yet within this the granulations have a deeper hue than those nearer to the centre of the ulcer, being most vascular where the cuticle is being actively developed. The pus from such an ulcer is "healthy" or "laudable" (see pp. 141 sqq.); the parts immediately beneath and around it are somewhat more vascular than is natural, but are not otherwise changed. Such are the characters, by their deviations from which all other ulcers are distinguished, and by their approaches to which they indicate their tendencies to healing. For the healing of a simple ulcer may be called spontaneous, as that of a granulating wound may be; and for both alike no other treatment is necessary than exclusion from injury.

Inflammatory ulcers are among those least different from the common type. They usually have their origin in some slight injury, a scratch or blow, such as a "broken shin," which a healthy person might have suffered with impunity. Their most common seat by far is on the lower half of the leg, and they are commonly single; they are usually less than an inch in any diameter, and of irregular shape; their bases are generally level, very little depressed, ragged or flocculent, without granulations, ruddy, looking raw, or else ashgray, or yellowish with adherent thin slough; their edges are abrupt, irregular, or shreddy; their pus, or ichor, is thin, watery, excoriating, not unfrequently blood-tinged. The skin round an inflammatory ulcer is usually full-red, bright or dusky according to the patient's general condition, hot and burning, and the whole seat and neighbourhood of the disease feel very painful, burning and aching "down to the bone;" not rarely, also, the surrounding tissues are œdematous.

An inflammatory ulcer, unless it be due to some constant external irritation, always indicates general unhealthiness in the patient, but not always the same defect or error of the health. It may be found in the well-fed and plethoric of all classes, but is probably most frequent in the infirm and old, the ill-fed and overworked. There is, therefore, no specific or single method for its general treatment. This must be decided by the condition of each patient, just as that of any other active inflammatory disease must be. For local treatment the chief means are leeches, applied at a distance from the ulcer, *e. g.* near the knee or on the foot, if the ulcer be at or near the middle of the leg; warm water-dressing, or lead-lotion applied warm, or poultices; complete rest of the part, and (if it be the lower limb) recumbency with elevation of the limb. Bandages, ointments, and plasters are usually to be avoided till the ulcer shows signs of healing. With less favourable changes, the inflammatory ulcer is especially likely to be excessively painful (see *neuralgic ulcer*, p. 216), or to become chronic; much more rarely it assumes strumous, or syphilitic, or other specific characters derived from some constitutional disorder in the patient.

Eczematous ulcers merit distinction from the preceding, although like them in many characters, especially in their most frequent seat, their usual shape and size, and characters of base and margin. They may have their origin in slight injury, the ulcers forming as in the last kind, and the surrounding inflammation assuming an eczematous instead of a common character, the skin becoming punctate or vesicular, or cracking and exuding an adhesive ichor with constant itching. But they are often spontaneous, the ulceration taking place in the middle of a patch of acute eczema.

In either case, the general treatment must be guided by the character of the disease of the skin. The remedies for eczema must be used, regard being had especially to the gouty, strumous, or other constitutional disposition with which it is in each case connected. For local treatment it may be noted that such ulcers seldom tolerate ointments or dry bandages. In general, the best applications are water-dressing or wet linen-strapping; if the skin around the ulcer exude profusely, it may be covered with daily-renewed pieces of blotting-paper, or dusted with starch, or, best of all, be occasionally washed with a strong solution of nitrate of silver, which is equally a good remedy for the ulcer itself.

It is probably these, more than any other ulcers, that have given rise to the question, whether ulcers should always be cured if possible. There is sufficient reason to believe that the cessation or cure of an established eczema has been attended with serious disease of the brain or other internal organ; the same may happen with an ulcer of this, or probably some other kinds. The event is certainly very rare, but it may often be right to guard against it by making an issue in some place more convenient than the ulcer, or by renewing the cutaneous disease with counter-irritants, especially by frictions with croton-oil liniment.

Although eczematous ulcers alone are here named, yet it may be noted that ulcers may occur in several other forms of cutaneous eruption. They are, indeed, usual in all the severer forms of the pustular, vesicular, and bullar eruptions in patients that are cachectic; whether with intense struma, or syphilis, or through defective food, foul air, or other depressing influences. But at present it is sufficient only to mention these ulcers; their diagnosis and treatment are to be determined by the eruptions with which they severally concur, and with the accounts of which they will be described hereafter.

Cold ulcers should be distinguished because of the peculiarity of constitution on which they depend, and which often has to be considered in the treatment of other ulcers of various kinds. They are like small inflammatory ulcers, occurring spontaneously in the extremities, especially at the ends of the fingers or toes, or at the roots of the nails. In some cases they are preceded by severe pain and small gangrenous spots. They are in many respects like ulcerated chilblains, but they occur without any exposure to intense cold, in patients whose feet and hands are commonly, or even habitually, but little warmer than the atmosphere they live in. Such patients are among those who say they are never warm; and the skin of their extremities, unless artificially heated, is to the touch like the surface of a cold-blooded animal. The blood must flow in these parts so slowly, that there is time for it to be cooled nearly to the temperature of the atmosphere; probably it is often stagnant, or scarcely circulating.* With this defect, which in its smaller degrees is very common, especially among women, the usual coincidents are a small feeble pulse, a dull or half-livid tint in the parts which in healthy people are ruddy, a weak digestion, constipated bowels, and scanty menstruation. The cure of the ulcers, and prevention of their recurrence, lie in the remedy of these defects. Many tonic medicines may be useful, but the most so is iron, in whatever doses the patient can take it. With it purgatives are generally necessary; *e. g.* small doses of mercury and aloes, or of sulphate of magnesia. Full diet, also, is usually required; exercise in the fresh air; very warm clothing, especially of the lower half of the body; and warm bathing. Dry applications, or lotions with sulphate of zinc or of copper, are the best local means, and the part must be kept warm; healing is always tardy or quite arrested at a temperature far below the natural heat of the body.

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* Experiments are wanting to prove how deeply this coldness extends.

Senile ulcers present, usually, many of the characters of inflammatory ulcers of the lower type, but should be distinguished because of the peculiarity of their origin and coincidents. They have no distinctive characters of shape or size, but are especially dry, secreting little even of ichor; and they have a kind of rusty-ruddy tint of their granulations, and are surrounded with a dusky-pink or red area. And these characters correspond with those of the tissues in which the senile ulcers are found, for they are most common in the dry withered limbs of those who are shrinking, as they grow old with either a timely or a premature degeneracy. The surrounding skin is usually dry, thin, brownish, scaly; it may be eczematous; and its veins, especially those near or below the ulcer, are large or stellate. Often, also, some part of the border of the ulcer sloughs; the slough, with a well-defined boundary, yellowish or grayish-white, extending into the adjacent skin. Thus, in some cases, the ulcer spreads at one part while it may be healing at another; extending with a kind of senile gangrene of the integument, similar to that in which it may have had its origin. Such spreading is usually preceded or accompanied by aggravation of the pain with which the ulcer is associated, but which, except at such times, is seldom considerable.

The general treatment appropriate for senile ulcers consists chiefly in giving such good food and wine as, under nearly all con-

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The writer put a thermometer in a wound made in the division of a tendo Achillis in a cold-footed young woman, and it showed only 70° F., the atmosphere of the room being 65°.

ditions, those who are withering require. Bark, also, is commonly useful, and the mineral acids; and in cases attended with sloughing, opium often appears to be a very valuable remedy. For local treatment, stimulant ointments, or balsams, or these in combination, commonly do more good than stimulant lotions, which rather wither the granulations that may be forming; or than water-dressings, which are apt to produce irritable eruptions about the sores. A very useful plan when the disease is extensive, is to strap the limb daily with a mixture of resin-ointment and Peruvian balsam spread on strips of lint.

Strumous ulcers, most of which, it is probable, might be also called tuberculous, are most commonly seen as the consequences of strumous or scrofulous suppuration in the subcutaneous tissue or lymph-glands; but they may appear without any such preceding disease. In this case, the usual stage previous to ulceration is that of slightly elevated, pale red or pink, circumscribed thickenings of the skin, like cutaneous tubercles. These may appear singly or in groups; and may, perhaps according to their duration, be firm, or softish, or boggy, as with a softening of their substance. This last state, which is, probably, a kind of imperfect suppuration or softening of tuberculous matter under the skin, immediately precedes the ulceration. The ulcers, whether formed thus or after the wide opening of strumous abscesses in the lymph-glands or subcutaneous tissue, are most frequent in the neck, groins, cheeks, scalp, and the neighbourhood of the knee, ancle, wrist, and elbow. They are often multiple and clustered. They generally affect an oval shape, but by coalescence may be irregular and variously sinuous and of great extent, though singly they rarely attain an inch in diameter, and have little tendency to spread. The margins of strumous ulcers are commonly formed of undermined, overhanging skin, which may be either thin or irregularly thickened, without induration, and either pale pink or purplish, according as the circulation is more or less free in them. The bases of the ulcers are usually unequal, soft, covered with large, soft, œdematous granulations, which are often pale, and bleed on slight contact, and sometimes project exuberantly above the surrounding level. The pus of strumous ulcers is commonly thin, greenish-yellow, seldom irritant; they are rarely very sensitive or painful. The parts around them may be healthy; but when they have existed long, and especially when they are connected with old strumous disease of bones or joints, all the adjacent textures are generally greatly enlarged with œdematous infiltration, and clogged together.

By these characters strumous ulcers may, almost always, be recognised; but the diagnosis is assisted by the coincidence of the known signs of the strumous constitution, or of similar disease in other parts or tissues. And these coincidences indicate the general treatment, of which the chief constituents must usually be either preparations of iron, especially the iodide, cod-liver oil, quinine, or iodide of potassium; occasional purgatives, or small doses of mercury; fresh air, especially by the sea; free exercise; bathing; and scrupulous attention to the digestive organs, which are very commonly disposed to receive more and other food than they can make good use of. The local treatment of the ulcers (excluding the cases in which they are connected with diseases of the bones or other deep-seated parts) must generally be stimulant. For different cases, which it may be impossible to define, the ointments with iodine, or the iodides of potassium, lead, or mercury, may, any or all of them in succession, be found valuable. Or lotions of the iodides may be used, or of the astringent metallic salts, or of nitrate of silver. An excellent way of applying these, when the ulcers are on the limbs, is with strips of linen or lint soaked in the lotion, and put on as firm strapping. Of numerous popular applications, the best, probably, is a poultice of bruised and warmed sea-weed. When the skin is very much undermined and burrowed, its destruction with potash, or some similarly acting caustic, is often very useful.

Cases occur, though rarely, in which amputation is the only remedy for strumous ulcers. They are chiefly when the ulcers are about the ankle-joint, and attended with great œdema of the foot, or when they are deep enough to have involved some bone or joint; but no general rules of treatment can be here laid down.

The scars of strumous ulcers may be causes of ugliness and deformity, either by contraction or, more commonly, by overgrowth, and the formation of bars raised in radiating lines, or networks, or tongues of skin. In such cases, excision of the scars may be necessary; but in many instances a great part of the excess of scar may be removed by repeated slight blistering, and with time nearly the whole will level down.

In superficial scrofulous ulcers on the hands and feet a peculiar appearance is sometimes produced by an excessive growth of the papillæ at the base or borders of the ulcer. In either, or in both situations, they give the ulcers a remarkably warty character—a character which is often maintained when the ulcers are healed—and leave a coarse, nodular, and warty patch of skin, with opaque, thick cuticle. At first sight, such ulcers might be taken for papillary epithelial cancerous disease; but the diagnosis is easy, through their being often multiple, having no hardness of granulations or of base, no sinuous or upraised border, no rapidity of progress.

These warty strumous affections may be cured with repeated paintings with tincture of iodine, or with the most stimulant of the iodine ointments.

Scorbutic ulcers. Popularly, many kinds of ulcers are thus named; especially the inflammatory, eczematous, and some of the strumous. But the name should be reserved exclusively for those that derive their peculiar characters from the existence of scurvy. Mr. Busk, whose great experience on board the Dreadnought Hospital-ship has given him an unequalled knowledge of scurvy, has kindly supplied the writer with the following note:

"Although scurvy in itself cannot be said to be attended with any peculiar form of ulceration, ulcers or sores of any kind already existing from other causes assume, in consequence of the scorbutic taint, a more or less peculiar character, and when thus modified have usually been termed 'scorbutic ulcers.'

"Scurvy essentially consists in an alteration in the constitution of the blood, which leads to the effusion into the various tissues of a fibrinous exudation, usually deeply coloured, and which has on that account been commonly regarded as a simple coagulum. That this effusion, however, can scarcely be regarded in this light, is proved by several considerations, but more especially by the circumstance that it is, from the first, solid and capable of becoming imperfectly organised, that is to say, it is after a time permeated by newly formed vascular channels. It is the presence of this effusion which causes the spongy swelling of the gums, the tumefaction and induration of the intermuscular tissue, the so-termed scorbutic nodes, and which, when poured out on the surface or in the substance of the corium, constitutes the vibices and petechiæ so characteristic of the disease. It is the effusion also of the same semiplastic material on the free surface of sores or ulcers which gives them the peculiar aspect termed 'scorbutic.'

"Ulcers of this kind are distinguished by their livid colour, irregular tumid border, around which no trace of cicatrisation is evident; whilst the surface of the sore is covered with a spongy, dark-coloured, strongly adherent, fœtid crust, whose removal is attended with free bleeding, and is followed by a rapid reproduction of the same material. This crust, in bad cases, as remarked by Lind, attains to a 'monstrous size,' and constitutes what has been appropriately termed by sailors 'bullock's liver.'"

Gouty ulcers. Persons of gouty habit are among those most liable to inflammatory and eczematous ulcers; but the form to which this name is specially given is that found in distinctly gouty parts, or over gouty deposits. Such ulcers are usually superficial; and even when they occur on the palm or sole, and extend through thick cuticle, destroy only the surface of the cutis. They are circular, if of any definite shape, with low shelving borders, and with bases that are either florid and without granulations, or covered with a thin yellowish or grayish layer, like a soft slough. They discharge a thin ichor, which commonly, as it dries, leaves a white chalky deposit; and they are exceedingly slow in getting either better or worse. The parts around them are usually healthy, except in so far as they may be gouty.

The general treatment of gouty ulcers must be determined by the general condition of each case. Locally they may be best palliated by the simplest applications, such as water-dressing or simple cerate; or cured by washing with solutions of from five to ten grains of nitrate of silver to an ounce of water.

Syphilitic ulcers. Those that are primary need no mention here, except to indicate the necessity of being on the watch for the diagnosis of such as occur on the lips, fingers, and other parts on which they are rarely seen, and more rarely suspected by the patients. And secondary diseases of the integuments are very seldom ulcerative, unless when pustular eruptions occur in the cachectic. Tertiary syphilitic ulcers, however, are so frequent, and their diagnosis from all others is so important, that, although it may involve repetition, they must be described here as well as elsewhere. They usually appear among the latest signs of syphilis, and are most severe in those who are most reduced, whether by the syphilitic poison abiding in them, or by mercury, or both, or by poverty, intemperance, or naturally unsound constitution. There is probably no form of ulcer in which the influence of all these evils is more intensely felt.

Two principal forms of tertiary syphilitic ulcers may be distinguished at, or near, the beginning of their formation; of which the one usually succeeds to rupia or some other ulcerating eruption, and the other follows subcutaneous induration with circumscribed infiltration of the tissues (*gummata*, as they are sometimes called). In their later stages, the two forms may be not distinguishable; but they generally maintain the difference of being, the one superficial, the other deep; the one extending through only the cutis, the other into or through the subcutaneous tissue.

The more superficial tertiary syphilitic ulcers may be known, in many cases, by being commingled with well-marked eruption; but when this is not the case, the signs most to be relied on are as follows. They may occur on any part, but are most frequent on the trunk, as on the back, shoulders, nates, and, in next frequency, on the limbs. Their most frequent shapes are circular, annular, or crescentic, or horseshoe-like. The annular shape, in which a round or oval portion of healthy or scar-like skin is surrounded by a ring of ulceration, which often extends at its outer border while healing at its inner, is almost certainly characteristic of syphilitic disease; and equally so is the ulcer in the shape of the crescent or horseshoe, which commonly heals from its concave, even while extending from its convex, border. Such ulcers may be single or multiple, and, in the latter case, may be grouped or arranged in a circle, or some other curvilinear figure. They may be of any size, from half an inch to five or six inches in diameter, and generally are smallest when they are most numerous. Their edges are usually abrupt, sharp-cut, or sometimes jagged; not undermined, or elevated; bounded by skin which appears little changed in texture, but may be ruddy, or highly vascular. Their bases are usually level, little depressed, uniform, dusky dark crimson, or more florid, with soft small granulations, if any. Their discharge very commonly concretes into scabs, which may partially or completely cover them, and may be heaped up like those of typical rupia.

Tertiary syphilitic ulcers of this kind are not usually associated with evident disease in the textures adjacent to them. They have themselves no induration, and, rarely penetrating beyond the *cutis vera*, they leave the subjacent tissues, as well as those round them, soft, pliant, and apt for rapid healing with scars that scarcely contract or adhere to parts under them.

Generally, the ulcers of this kind are not associated with any other active form of syphilitic disease, though their diagnosis may often be assisted by the marks of such disease past-by. Neither have they any attendant constitutional disorder other than belongs to the several degrees of syphilitic cachexia; and they are seldom very painful, unless when seated on the hands or feet.

The deep tertiary syphilitic ulcers usually have their origin in circumscribed indurations, of a doughy, inelastic consistence, in the subcutaneous tissue. Such indurations are at first painless, and scarcely involve the cutis: it passes smooth over them, level, or but slightly upraised. But after the lapse of an uncertain time (it may be less than a week, or more than a month), the central part of the induration becomes soft, feels boggy or rotten; the cutis becomes adherent, red and thin, and all the diseased part more painful. Then the thin skin ulcerates, and at once the diagnostic characters of this form of ulcer are established.

Such ulcers are most frequent on the extremities, especially near the knee or the elbow; but they may be found any where, and are not rare on the lips, forehead, alæ of the nose, and other parts of the face. They are usually circular or oval, seldom less than a quarter of an inch, or more than an inch, in diameter. There are more often many, than one, at the same part, and not rarely several are found in different stages, or of different dates of formation. The edges of these ulcers are usually very sharp-cut, abrupt, sometimes going right down through the thick substance ef the induration, as if a piece had been punched out of it. The edges are rarely either undermined, elevated, or everted; and as they extend, the whole substance of the induration is pretty uniformly destroyed. Their bases are not unfrequently covered with slough, due apparently to the degeneration and death of the indurated substance in which the ulcer had its origin. Or, when not sloughing, the bases of the ulcers are commonly deeply excavated, without evident granulations, resting on the deeper subcutaneous tissue.

Ulcers of this kind are seldom painful unless when accidentally inflamed, and are remarkably little affected by posture or those other external conditions which notably modify the characters of ulcers that are less evidently specific. The tissues adjacent to the induration which surrounds these ulcers are in the first instance little affected; but as the disease extends, they may become even very deeply involved, *e. g.* to the deep fasciæ, or muscles, or periosteum. Very commonly, too, an area of dusky redness surrounds the ulcer, and the duskiness may be noted as one of the signs by which these tertiary syphilitic ulcers may be distinguished from certain strumous ulcers which are much like them, but have surrounding areas of a bright pale pink.

A well-marked, though not intense, cachexia is often (but far from always) associated with these ulcers, and periosteal or osteal pains may coexist. Yet more generally they are the only present signs of syphilis; the disease seems to localise itself in them; and it is not very rare to find patients, who have continued for ten or more years subject to these ulcers, but to no other form of syphilis, and even having these ulcers on only one part, *e. g.* on one lower extremity.

Little need be said here of the treatment of the tertiary syphilitic ulcers. It must be according to the general rules which will be laid down in the essay on SYPHILIS; yet a few rules may be mentioned. As with all specific ulcers, so with these; specific treatment is of little or no avail, but may be mischievous, while they are the seats of acute inflammation. This, though it be but an accidental complication, must be reduced by ordinary means before specifics can be profitably given. Iodide of potassium, in such doses as three grains thrice a day, very rarely fails to cure any ulcers of either the superficial or the deep form; but just as rarely is the cure permanent. Again and again after treatment with this medicine ulcers recur in or near the scars of their predecessors; and the choice lies between repeating such temporary cures, till in time the disease as of itself ceases, or the employment of mercury.

The local applications must generally be stimulant; and among the best materials for dressings are the ointment of the nitric oxide of mercury and the black wash. If there be no acute inflammatory or other complication, either of these may be used till the ulcers are completely healed. In the event of such complications, the tertiary syphilitic ulcers are among those for which the plan of water-strapping is best adapted.

In connexion with the history of these tertiary ulcers, it should be mentioned that ulcers exactly like them may be found in young persons that have inherited syphilis; that there is some reason to believe that they may be imitated by the effects of mercury given for other than syphilitic diseases; and that when tertiary syphilis occurs in persons of strumous constitution, ulcers may appear of intermediate characters, in which it may be impossible to make a diagnosis, unless by the influence of iodide of potassium, which appears to be the greater in the same proportion as syphilis enters more largely into the constitution of the disease.

Lupous ulcers will be described in the article on the DISEASES OF THE SKIN, the tubercular condition of the cutis which usually precedes them having given to "lupus" a claim to a place among cutaneous eruptions; but their chief diagnostic characters may be mentioned here. Occurring usually in persons of marked strumous constitution, they are most frequent on the face, especially on the tip or alæ of the nose, and the upper lip or cheek. Often also they are seated on the boundaries of the skin and mucous membrane of the nose, extending on both; or, with ulcers on these parts, others may be found perforating the septum of the nose or in the pharynx. They are commonly preceded by one or more flattened, slightly elevated, firm, oval or roundish, pink tubercles or thickenings of the cutis. These perish in the ulceration, and the extension of the ulcers is not usually preceded by thickening of the cutis next to be invaded. The ulcers take the shape and number, and in the first instance the size, of the tubercles; but they soon extend and coalesce, destroying in their progress not cutis alone, but the deeper textures, as the cartilages and bones of the nose, the mucous membranes, or any others that may stand in their course. And this progress is not with sloughing or any signs of active inflammation, but with constant and, it may be, slow ulcerative destruction of the borders of the ulcers.

The borders are generally abrupt, irregular, "eaten," sometimes slightly elevated or thickened and firm, very rarely undermined. The bases may be nearly level, pale, and almost void of granulations, or they may be covered with coarse, dusky, prominent granulations raised highest at the centres. In either case the ulcers are very often scabbed over, by the drying and concretion of their discharge; but the scabs do not facilitate scarring beneath them; rather, they favour the progress of the ulcers. The ulcers are seldom painful or prone to bleed, even when their granulations are prominent, and the parts around them and beneath their bases are generally healthy. Coincident with them may be any form of strumous disease or of its consequences.

Lupous ulcers are the first to which can be ascribed that property of cancerous or malignant diseases which consists in their proneness to extend irrespective of tissues. But this character is not sufficient to prove that they have relationship to cancer; their most evident affinities are with struma. These indicate the most useful constitutional treatment, namely, that with cod-liver oil (which may need to be given in very large doses) or other remedies for struma. And it is to be observed that when tertiary syphilitic ulcers occurring on the face imitate many of the characters of lupus, these remedies are wholly useless for them, even more so than is iodide of potassium for the true lupous ulcers of strumous origin. But besides, local treatment is essential. A long course of very active stimulants, such as turpentine, may heal lupous ulceration; but such healing is insecure, and the disease is very apt to return in the scar. It is better to destroy the whole borders and base of the ulcer thoroughly with some escharotic, which may penetrate far enough to reach healthy structures. What escharotic should be chosen must be determined by the conditions of each case.

Rodent ulcers (also often called lupoid, cancroid, &c.) have several characters in common with those last described; yet their difference is proved, among other distinctions, by their occurring as generally in the later half of life as the lupous do in the earlier; and by their affinity with cancer, and not with struma.

They usually originate in some tubercular or scaly spot of long duration on the face, on which repeated formations and off-castings of dry crusts and scales may have been observed. Their most frequent seats are the cheeks, eyelids, upper lip, nose, and scalp; but ulcers of essentially the same characters may occur on the vulva, vagina, areola of the breast, or perhaps many other parts. They are usually single, and not symmetrical; circular or oval in the first instance, but in their progress becoming quite irregular in shape, extent, and depth. Their borders are seldom much elevated or distinctly nodular or lobed; but are usually smoothly rounded, or with low tubercles in or near them, not undermined or everted. Both the borders and the base feel tough or hard, as if formed or bounded by a layer of indurated tissue from half a line to a line in thickness. Beyond this layer all the tissues adjacent to a rodent ulcer appear healthy. The surface of the base is generally smooth, and, it may be, level; dull reddish yellow, looking half-dry and glossy, void of granulations, yielding very little discharge of any kind. It very rarely bleeds, or gives acute pain, or has any exuberant up-growth of granulations, or any warty or lobed structure, such as is so common a characteristic of the epithelial cancerous ulcers, to which, in some respects, the rodent bear a close resemblance. In very rare cases, a distinct subcutaneous growth may be found at the border of a rodent ulcer. In such a case, the writer found a firm, elastic, rounded mass, nearly an inch in diameter, pale-grayish, yielding no cells or other structures like those of epithelial or any other form of cancer, but small corpuscles like those of ordinary granulations.

The progress of a rodent ulcer is usually very slow, but if not checked by treatment, it is very sure, and at any time liable to be accelerated by accidental inflammation. It constantly extends wider and deeper, destroying every tissue that it invades, yet maintaining throughout the same general characters of base and border, and the same usual absence of attendant growth. Such ulcers may destroy great portions of the face, and penetrate so as to expose the pharynx or the nasal cavities, or the brain, or any deepest-seated part. Thus they may be fatal; but to the last, they have no associated similar disease in the lymphatics, or in any distant part, and no other cachexia than may be due to the feebleness which they cause. Indeed, it is often a subject of wonder when the contrast is observed between the horrible ravages of a huge rodent ulcer of the face and the apparently undiminished general health and strength with which the patient bears it. In no other equally destructive disease is such a contrast seen.

The treatment of rodent ulcers must be complete extermination. The knife, or escharotics, may be used, according as the circumstances of each case may decide for one or the other; but generally escharotics are to be preferred, as being equally efficacious with excision, and attended with less risk. No general rule can be given for choice of escharotics; but usually, for the smallest ulcers, arsenic is most convenient; for the larger and more superficial, the nitric acid, or acid nitrate of mercury; for the larger and deeper, the Vienna paste, or pastes with chloride of zinc. After thorough extirpation of all the boundaries of the ulcer, and of whatever tissue near it may be indurated, there is, generally, no return of disease. If there be, similar treatment must be resumed; and it may be continued as long as there is any probability that the whole disease may be destroyed at once.

Cancerous ulcers vary according to the forms of cancerous growth with which they are severally connected, and with the description of which they will be again referred to. But for their diagnosis from other ulcers, two modes in which they occur should be noticed. In one, the ulceration begins in the skin over, and adherent to, a cancerous mass, into which it extends as it deepens; in the other, the first changes appear to be in the cancer itself, and the ulceration is by opening of the skin from within. The two modes may coincide, and their final results may be the same; but the distinction between them is worth observing.

In the ulceration from the surface inwards, the skin over a cancer becomes gradually thinner, adherent, tinged with blood, dusky-red or brownish; then it cracks, or is excoriated, or scabs; the excoriation widens and deepens, till the surface of the cancer is exposed. If, now, the cancer be prone to rapid increase (as medullary cancers usually are), it will generally protrude through the ulcerated opening in the skin, as a so-called fungous mass; if less active, the ulcer generally deepens into it, and then may acquire slowly the characters of those that commence in the cancerous substance.

In this manner of formation, the cancerous ulcer may have no characteristic shape, but may be known from any of the forms already described by the characters of the morbid growth beneath it; and from ulcers over other than cancerous growths (at least in most cases) by its occurring not through stretching or mere inflammation of the skin, but through the skin becoming constantly thinner, and then in its residue cancerous, *i.e.* infiltrated with cancer.

In the other manner of ulceration, degenerative changes usually first ensue in the cancerous mass, with softening, and, it may be, an ill-conditioned suppuration. The materials thus formed are discharged, with sloughing or ulceration, through the surface, leaving in the cancerous mass a cavity like that of a widely-open abscess walled-in with cancer. Then, with continued ulceration of their internal surface, and at their open margin, the cancerous boundaries of the cavity or ulcer still constantly increase by the addition of new cancerous matter; so that, though the ulcer continually enlarges, it does not destroy the cancer; rather, the growth extends more rapidly than the destruction, involving the adjacent structures more and more widely and deeply.

The essentially distinctive character of these ulcers is the cancerous structure which bounds them, and in which, indeed, rather than in any natural tissue, they are found. To the growth of this structure, also, they owe chiefly their shape and other features. They are usually roundish or oval in their general outline. Their edges are generally raised and everted by the exuberant formation of cancer in and beneath the boundary of skin; and the raised margin, which may be also undermined, is usually hard, nodular or warty, and sinuous, imitating the structure of the cancerous mass. The base of a cancerous ulcer is similarly hard, nodular or warty, or covered with coarse granulations, uneven, deepest at its centre, not rarely bleeding without apparent cause. The discharge is usually a thin, acrid, strongly smelling ichor, which, in cases of superficial ulcers, and in old persons, often concretes into a dry and almost horn-like scab.

The structures beneath and around a cancerous ulcer being usually infiltrated with cancer, are hard or firm, through a layer from a line to an inch or more in thickness. The adjacent skin may be warty, with large papillæ. The lymph-glands in relation with the seat of the ulcer may be enlarged and hardened, and may thus give decisive evidence for diagnosis, if they maintain their morbid condition although there be no accidental irritation or inflammation in the ulcer. For, with such irritation, any ulcer, as well as a cancerous one, may give rise to a corresponding enlargement of lymphatics.

The treatment, and other matters relating to cancerous ulcers, will be considered elsewhere (CANCER).

It remains to describe briefly those varieties in the characters of ulcers which depend on local or other non-essential conditions. Many of these, as already stated, have suggested names by which, as if they were specific distinctions, ulcers are often called and classified. These names may be respected if used in subordination to such as may imply the conditions on which, more essentially, the several forms of ulcers depend.

Varicose ulcers are such as are connected with an enlarged or varicose state of veins. They are found almost exclusively on the lower extremities, and especially on the lower half of the leg. The connexion of ulcers with varicose veins is far from uniform. In some cases it is scarcely more than an accidental coincidence. A patient with varicose veins may have an ulcer of specific origin and form, and its characters and progress may be no further affected by the disease of the veins than so far as that disease is a hindrance to the circulation. Generally, too, the more evidently specific the ulcer, the less is it modified by the disease of the veins. In other cases, an ulcer has its origin in inflammation of a varicose vein, beginning in a patch of skin which is inflamed and suppurates over a varicose vein that is hardened, and probably filled with clot. And, in yet other cases, the defective movement of blood through varicose veins appears to favour greatly the occurrence and ill progress of that low inflammation of the integuments in which ulcers are most prone to form. This is especially the case in patients in whom the disease of the veins involves, not the larger subcutaneous trunks and branches, forming tortuous and convoluted thick-walled canals and clusters of veins, but the smaller cutaneous veins, which, in their dilated state, appear turgid and stellate near the very surface of the skin. Of the two forms of enlargement of veins, often coincident, yet not rarely seen apart, this latter is by far the worst concomitant of ulcers of the integuments. It is through this, especially, that so many of the most painful inflammatory and eczematous ulcers at the ankles are described as beginning and always aggravated in pregnancies; and through this that, in advancing years, the healing of ulcers at or near the ankles is so slow and insecure.

Although, as already stated, any ulcer may be complicated with varicose veins, yet they are most commonly found with the inflammatory and eczematous and chronic. And with all alike, the remedy of the defective circulation is essential to a speedy and secure recovery. Constant recumbency, and elevation of the limb, are the simplest means to this end; but with many patients they are the least possible. Their best substitute, and that which is usually necessary for after-treatment, is regulated pressure, with bandages, strappings, elastic stockings, or the elastic spiral band; the materials for the strapping, whether wet lint, plaster, ointment, or any other, being determined according to the character of the ulcer. The obliteration of the veins, by any of the means that will be described in the appropriate article, may also be advisable, especially in the case of chronic ulcers. And the complication of diseased veins increases, if possible, the necessity of improving defects of the general health; every unnecessary hindrance to the circulation in any part should be removed, and every help given to insure a normal excretion, and full action of the heart. Among all medicines for this class of cases, iron appears to be the most effective; there are comparatively few cases of "varicose ulcers" in which it is not beneficial, and it is most so when the smaller cutaneous veins are involved. Opium, also, is of much value; most so when the ulcers are most chronic.

Œdematous, or weak ulcers. These terms have been somewhat vaguely used, but are best and most often employed for ulcers whose granulations are upraised, pale, translucent, soft, easily breaking, such as those usually are which are connected with scrofulous bones or joints. Except in connexion with well-marked scrofula, or with disease of deeper textures, such ulcers of the integuments are not frequent. They may occur on an œdematous limb, the granulations partaking of the general serous infiltration; but more commonly they owe their peculiarity to their granulations being constricted by surrounding skin or scar. In the former case, the remedy, or rather the reduction of the ulcer to a more common form, depends on the curability of the general œdema; in the latter, it may be effected by nitrate of silver, or astringents, as sulphate of zinc or of copper, or by dry pressure.

Exuberant ulcers. Ulcers are sometimes seen, especially on the feet and hands, which, without any apparent cause, exhibit an excess of granulations. Their granulations rise prominent beyond the adjacent skin, and overhang it, and are not œdematous, but as florid and compact as those of a healing ulcer. Escharotics, or pressure, or both, will cure this peculiarity. Till its origin be known, its chief interest may be in the likeness which it sometimes bears to the exuberance of ulcerated cancer. The diagnosis may rest chiefly on the feeling of the granulations; the cancerous are hard, or at any rate very firm, and fixed on a hard basis; those that are merely exuberant are not hard, but soft, fleshy, easily yielding to pressure.

When speaking of these ulcers with outgrowing granulations, it may be well to note that when an ulcer or fistulous canal opens into a synovial cavity whose lining membrane is in the state of so-called pulpy degeneration, an exceedingly exuberant growth of granulations may ensue, with an appearance of eversion of the synovial membrane through the ulcerated opening. Hence the remarkable aspect of certain ulcers connected with diseases of joints and sheaths of tendons.

Hæmorrhagic ulcers constitute no distinct class, and their diagnosis and treatment must depend on other things than the mere bleeding. Some ulcers bleed, being vicariously catamenial; some through excessive venous fulness, or the bursting of a subjacent varicose vein; some, as phagedænic or sloughing, through extending into some blood-vessel; some, especially the cancerous, or those that are connected with ulcerated tumours of any form, through the giving-way of thin-walled new vessels; some, because of the existence of scurvy or the hæmorrhagic diathesis.

Neuralgic or irritable ulcers. The pain of some is so great and so disproportionate to all their other symptoms, that they may deserve one of these as a subordinate name. The pain of some examples of inflammatory and eczematous ulcers has been already mentioned, and is unexplained; so is that of many ulcers connected with small varicose veins; but the type of ulcers, whose pain having no satisfactorily proved cause may be called neuralgic, is in those small, flat, oval, or circular ulcers that occur at the margin of the anus,—the so-called irritable ulcers or fissures of the anus. These show well how very little power any sedatives, locally applied, have to subdue the pain of ulcers. The only remedy is in the cure of the ulcers, whether by section for those at the anus, or by whatever means might be required for ulcers of the same kind not attended by unusual pain. Nitrate of silver, for example, will do more to assuage a neuralgic eczematous ulcer than any opiate application. It is, indeed, remarkable that when such ulcers are brought to healthy granulation they are scarcely painful, and their scars are not more sensitive than those of any other form.

Inflamed ulcers. Any ulcer may become accidentally inflamed. The signs of this event are, increased pain in and about it, a diffuse redness, or a brighter redness of all the adjacent skin, with more or less of œdema, a more copious discharge, often tinged with blood, and swelling of the granulations, with mottled, ruddy, and tawny colours, or with partial sloughings of them. Commonly, too, the edges of the ulcer look more abrupt and jagged than they did, and extend more rapidly. The popular expression, "angry-looking," figures very well the aspect of the inflamed ulcer. The remedy for this state is in some such treatment as the same patient might require for any other inflammation. Rest, elevation of the seat of the ulcer, the removal of local irritants, water-dressing, poultices, generally suffice for local means, or leeches may be applied; while the general treatment is to be decided by the general condition of the patient. For at least one variety of ulcers—the chronic or callous—an active inflammation is often beneficial, inducing changes which are followed by a more rapid healing.

The chronic, indolent, or callous ulcer has some of its chief characters told by these names. It is rare on every part except the leg, most frequent on its lower half; of uncertain size and shape, but most often oval, with its long axis parallel with that of the leg, or, when very large, encircling the leg. Its base usually lies deep, and is flat, pale, or tawny and dusky, with very minute or no visible granulations, compact and nearly hard, and adherent to the fascia beneath it. The margin is usually abrupt, or unequally shelving, and, in its most characteristic form, "callous," thickly overlaid with opaque, white, dense epidermis. Both the margin and all the surrounding integuments, often for many inches distant, are thickened, hardened, "callous," sodden, as with a kind of very firm œdema, and adherent to the subjacent fascia. The surrounding cuticle, also, is often shining and scaly, or dusky with pigment. The ulcer itself is generally almost painless, unless accidentally inflamed; its secretion is a thin ill-smelling pus; its most frequent complication is large varicose veins higher up on the limb.

Any ulcer of the leg may become thus chronic and callous when it exists very long; and when a distinctly specific ulcer thus changes, it not only loses its specific characters, but ceases to be amenable to specific treatment. Thus, the more a tertiary syphilitic ulcer becomes like a chronic ulcer, the less is the good influence of iodide of potassium upon it. But all ulcers are not equally liable to the change to "callosity;" the strumous are much less so than the tertiary syphilitic, and the inflammatory and eczematous are more so than either. And although in general the peculiarities of the chronic ulcer may be due to a long-continued slow inflammatory process, probably attended with production of lowly-organised, interstitial, new formation, yet in some cases the complete characters of the ulcer are attained in three or four weeks. This is most likely to happen in elderly people, ill-fed, or cachectic, with firm œdema about the feet and ankles, in whom ulceration is excited by any ordinary cause.

Through whatever course it may have passed, the chronic ulcer is usually amenable to treatment. It would be hard to enumerate all the means that have gained a reputation for curing it. Those which are certainly very good, and very rarely insufficient, are opium, regulated pressure, and blistering. Either of these, combined with rest, good food, and attention to the general health, will cure any but the very worst examples of chronic ulcer; and even in less advantageous circumstances, they will seldom fail. The doses of opium usually found sufficient are a grain night and morning; and the local treatment may be with stimulant ointments, such as that of the nitric oxide of mercury, or lotions of zinc or copper, or either of the following means. The regulated pressure is commonly and effectually applied with straps of adhesive or lead plaster on linen (on Baynton's plan), or, if the skin will not bear plaster, the strapping may be better done with linen wet with water or any appropriate lotion. Blistering should have for its design not only, if at all, the stimulating the ulcer itself, but the softening and thinning of its callous edges and adjacent tissues, which it seems to accomplish by causing absorption of part of the exudation with which they are infiltrated, and desquamation of the cuticle with which they are covered. With a similar view, a good auxiliary to any other mode of treatment is the scraping-off the thick epidermis from the margin of the ulcer.

In the worst cases, when all these means fail, it is commonly because the base of the ulcer and the integuments surrounding it are so indurated and so adherent to the subjacent tissues, that they will neither stretch nor slide towards the centre of the ulcer, even when healthy granulations form on it and would contract in developing into a scar. To remedy this hindrance of healing, it is sometimes useful to make incisions through the integuments, near and parallel to the margins of the ulcer, so that the gaping of the incisions may give opportunity for the contraction of the granulations on the ulcer. In similar cases, transplantation of an adjacent portion of healthy integument, sufficient to cover-in the ulcer, has cured it. In the worst examples, and especially in those in which a chronic ulcer over the tibia has excited thickening of periosteum, and formation of new bone beneath its base, and is firmly adherent to the structures thus changed, the healing, even if it be achieved, is so unsound that amputation is advisable; and it should be done through healthy and mobile integuments, or the result will be an unsound stump.

Phagedænic and sloughing ulcers. Nearly all the chief points of interest connected with the ulcers thus called, will be considered in the essays on GANGRENE and SYPHILIS. Here it may suffice to say, that such rapidity of extension as may deserve to be named phagedænic is very rarely seen in ulcers, except in connexion with syphilis, or hospital gangrene, or some similar condition. In acute inflammation, any ulcer may enlarge quickly; but the rapid destruction generally implied by phagedæna has a specific, and probably, also, an external source. Sloughing is a much more common complication of ulcers; sloughing, that is, not so much of their edges and adjacent parts as of their granulations. Thus, in inflammatory ulcers, the frequent appearance of a grayish or yellowish base is generally due to sloughing of granulations; so in senile ulcers, sloughing is very common; and in any form, in old persons, senile gangrene of the integuments around the ulcers may ensue. So, again, the whole base of a great chronic ulcer may often be seen sloughing, through injury, or defective food, or exposure to hard weather.

Such are the chief forms, both principal and subordinate, of ulcers of the integuments, of which sufficiently numerous instances may be seen to allow of their being described in general terms. A closer and more express study of the subject would certainly lead to the discovery of many forms which are not here indicated, because they are known to the writer by only a few instances, incompletely observed. The characters of ulcers, if more fully studied, both in well-marked, and in modified and complicate examples, would be found as various, and, severally, at least as well-defined, as are those of cutaneous eruptions; and with the better diagnosis that would be thus attained, there might follow a much better discrimination of the means of treatment appropriate for each.

JAMES PAGET.

ERYSIPELAS.

A DIFFUSED, spreading inflammation of the skin, involving more or less deeply the subcutaneous tissues, preceded and accompanied by febrile action, and dependent on constitutional causes.

The term Erysipelas* has been applied to a variety of forms of inflammation which probably have no true connexion with one another. On the other hand, distinctions have been made between forms of inflammation which are merely modifications of the same essential disease, erysipelas. The term is now, however, very properly restricted to a spreading inflammation, usually of an atonic character, the result of a peculiar morbid state of the blood.

Of so specific a character is the disease, that in one of its forms at least it is generally recognised as belonging to the order of contagious exanthemata. It resembles the true exanthemata, in its being sometimes infectious and sometimes epidemic, in its having its period of incubation, and a general tendency to definite duration. It differs from them in its liability to frequent recurrence, in perhaps the occasional absence of premonitory fever, and in its limitation usually to portions of the skin only.

By Willan it has been placed amongst the vesicular eruptive diseases, from the disposition to the formation of bullæ or vesicles. These, however, are only accidental.

The term erysipelas, according to Dr. Watson and others, should be restricted to the diffuse inflammation of the head and face. This may certainly be taken as the type of true simple erysipelas; but it may fairly be questioned whether it really possess any peculiar character.

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* The derivation of this term has occasioned some discussion: for the following note on the subject I am indebted to Mr. Robson, the printer of this work: "There seems to be no difficulty, etymologically, in deriving ἐρυσίπελας from ἐρυθρός *red*, and πέλλα *skin*. The stem of ἐρυθρός is undoubtedly ἐρυθ-, Lat. *rub-* in *ruber*, Germ. *roth*, Engl. *rud-* in *ruddy*, *red*. With regard to the change of the θ into σ in some compounds, Benfey in his *Griechisches Wurzellexikon*, vol. ii. p. 125, says: 'ἐρυθίβη rhodisch, wie ἐρυθίβιος zeigt, in der κοινὴ σ=θ, ἐρυσίβη;' which accounts for the σ instead of θ in ἐρυσίπελας. And for -πελας from πέλλα, Liddell and Scott (*Lexic.* s. v.) compare ἄπελος, to account for the single λ."

Looking to its causes, the disease may be divided into Symptomatic Erysipelas (*E. consensuale*),—the expression of some pre-existing constitutional disturbance; Idiopathic Erysipelas, — the result of general causes acting on the system from without, such as exposure, miasm, or epidemy;* and Traumatic Erysipelas,—where the inflammation is directly excited by local irritation or inoculation. The classification into symptomatic and idiopathic is not perhaps practically important; that into traumatic is more so, inasmuch as the severe forms of inflammation of the subcutaneous tissues usually follow wounds and other local injuries.

There are two principal varieties which are now universally distinguished: Simple Erysipelas (*E. simplex*, *verum*, *legitimum*, *superficiale*, *febris erysipelatosa*), the cutaneous erysipelas of Mr. Nunneley, where the inflammation is more or less limited to the skin, the subcutaneous cellular tissue being only slightly or not at all affected; Phlegmonous Erysipelas, or the cellulo-cutaneous of Nunneley (*E. phlegmonodes*, *pseudo-erysipelas*, *phlegmon diffus*), in which the inflammation partakes somewhat of the character of phlegmon, affecting concurrently with the skin, the cellular and adipose tissues beneath, and generally running on to suppuration.

There is no real boundary between these two varieties. Simple erysipelas usually involves the cellular tissue to a certain extent, and may even be followed by suppuration in it. Phlegmonous erysipelas will often terminate in resolution. A third variety is perhaps admissible — Œdematous Erysipelas (*E. œdematodes*); for although œdema is always present, more or less, in this disease, and largely so in situations where the skin is lax, as in the scrotum or eyelids, yet in some states of system the cellular tissue is loaded with serum beyond what would be expected from the amount of cutaneous inflammation, which in these cases often does not present its usual bright colour. There is yet one form of inflammation which, although in it the primary affection of the skin is absent, is yet so identical with erysipelas in its causes and in most of its essential characters, that it cannot properly be dissociated from it, namely, diffuse cellular inflammation,—the cellular erysipelas of Nunneley.

These various forms of inflammation and their modifications must be regarded but as phases of one disease, which has its seat not merely in the part, but in the system. The form which the disease may take is determined by the state of system, the temperament, habits, &c. of the individual, or the external causes which produce it.

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* The terms 'idiopathic' and 'symptomatic' are often used in a reversed sense from that given in the text; which is, however, more in accordance with the real meaning of the words, and has been adopted by Mr. Lawrence and many of the best authorities.

In adopting this view of the nature of erysipelas, which is supported by its infectious nature, by the occurrence of premonitory fever, and by its definite course, it is desirable to discontinue the application of the term erythema to its milder forms. The latter term has been applied to every form of simple local efflorescence of the skin, whether arising from internal causes or from external irritation merely. It is, perhaps, practically difficult to draw a line between them in all cases, though the real distinction is obvious. Erysipelas presupposes a specific determining cause; but those forms of cutaneous diffuse inflammation which arise from external causes only, as stings, burning by chemical or other means, friction (*intertrigo*), or from the irritation produced by the introduction of indigestible food into the stomach, are in no way allied to it, and may be properly classed under the head of erythema.

Besides diffuse cellular inflammation, there are many diseases which do not produce the characteristic cutaneous inflammation of erysipelas, yet are probably closely allied to it, as *e. g.* phlebitis both external and internal, inflamed absorbents, and puerperal fever.* Such, too, is perhaps the case with some forms of inflammation of the mucous and serous membranes. For though the essential character of erysipelas (inflammation of the skin) be absent, yet if the constitutional condition be the same in all, they must be regarded as pathologically identical, however the expression of the condition may differ; just as in syphilis the same virus may produce simple chancre or phagedænic sore, or various forms of cutaneous disease, or deep-seated inflammation.

It has been objected by Mr. Lawrence, who in this supports the views of Vogel and Hildebrand, that to justify the notion of the mucous or serous membranes being affected by erysipelas, it must be shown that the same phenomena are observable in them as are seen in the skin.

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* Velpeau, in his clinical lecture on erysipelas (*Leçons orales*, vol. iii. p. 235), classes together angeioleucitis, external phlebitis, diffuse phlegmon, and true erysipelas; though he maintains that they are widely different from one another. But he describes diffuse phlegmon as differing from what he considers true erysipelas (*E. légitime*) to as great an extent as angeioleucitis or external phlebitis do from either of them.

Mr. Lawrence says, "erysipelas is merely a particular modification of cutaneous or cutaneous and cellular inflammation;" and he adds, further on, "I can, however, by no means agree with those who regard it as a distinct species of inflammation, and as capable in that character of affecting various parts of the body as well as the skin. Some writers have referred to erysipelas certain inflammations of the conjunctiva, mouth, and fauces; of the respiratory and alimentary mucous surfaces; of the serous membranes in the head, chest, and abdomen; and of the brain, abdominal and thoracic viscera. The proof of such an opinion would consist in showing that the same peculiarities, which distinguish erysipelas from other inflammations of the skin, are found in certain inflammations of the parts just enumerated, and that such affections may hence be distinguished from ordinary inflammations of the same organs."* The whole force of this objection rests on the assumption that there is nothing specific in erysipelas, but that it is merely a modified form of ordinary inflammation. This is the opinion entertained by many French pathologists, and by Mr. Lawrence and others in this country. Mr. Lawrence, for example, believes that, in respect to cause, "there is really no difference between erysipelas and other inflammations." If, however, the view more generally received at the present day be correct, that erysipelas is the expression of a peculiar state of system, the result of some poison introduced into or generated in the body, then it is no longer necessary to find identity of character in the inflammations of the internal and external surfaces affected by it. Thus no one would deny to the sore throat of scarlet fever a special origin, though often the characters of the inflammation in no way differ from those of a simple non-contagious sore throat. Indeed the argument of Mr. Lawrence, founded on the state of the throat, is answered by what is seen in scarlet fever. He observes that the swelling and vesications of erysipelas are not found in the inflammations of the throat attending erysipelas, "which, on the other hand, are frequently attended with ulceration, with the formation of an ash-coloured or tawny substance adhering to the surface, and with superficial sloughing; occurrences either very unusual, or not belonging at all to erysipelas."† Now in scarlet fever the skin-rash never goes beyond a mere efflorescence, with sometimes a slight vesicular eruption. But in the mucous membrane of the throat, ulcerations preceded by ashy or white exudation are common. The sore throat partakes, neverthe-

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[*] *Medico-Chirurg. Trans.* vol. xiv. p. 19.

[†] Loc. cit. p. 22.

less, as much of the specific nature of the disease as the rash. And so in those cases where the recession of the inflammation of the skin has been immediately followed by deeper-seated inflammation, there need be no special character to mark the nature of the disease, though the inflammation may really depend on special causes.

Although erythema is regarded as differing from erysipelas in its essential character, yet from a certain similarity between the two, it may be well to give a short description of this disease. Erythema is a pale-red efflorescence invading only the superficial layers of the skin, though sometimes œdema is present, but as a cause, not an effect of the inflammation. In general it is accompanied by only trifling swelling, which soon subsides. It appears in irregularly circumscribed patches,—sometimes there may be but one, oftener there are many,—which have not the tendency to spread widely, and join like those of erysipelas; they rarely exceed a few inches in extent, and in some forms are not more than a quarter of an inch in diameter. The patches may appear on any part of the body; their most usual seat is the chest and limbs, and they are generally confined to the part in which they first appear, though this is not invariably the case. The course of the disease is generally acute, from four or five days to a fortnight in duration: sometimes it is chronic, and it is said even to be intermittent. Usually the eruption is unaccompanied by fever, and in most forms is unattended with pain.

Many varieties of this disease have been described, some of which seem to have little alliance with one another. Indeed erythema appears to be a symptom common to a variety of states of system and to mere local irritation.

Symptomatic erythema appears in the course of other diseases, or arises from some transient constitutional disturbance, as from errors of diet, teething, or irregular menstruation. It occurs generally in persons of irritable lax habit with delicate skin. In many persons the slightest causes induce an attack.

Fugacious erythema (*E. fugax*) is frequently associated with other and more serious diseases, especially long-standing disease of the alimentary and other mucous membranes. But there are few internal affections which may not at times be accompanied by it; and it is often an indication both of their presence and their severity. It comes on, however, simply from errors of diet, particular articles of food, as shell-fish, pork, &c. invariably producing it in some individuals. A case occurred to me in which the mere touch of laudanum would bring it on. It appears in the form of variously-sized diffused patches, invading chiefly the upper parts of the body, and occurs most frequently in females. The peculiar character of this variety is its tendency to disappear suddenly at one part, to make its appearance again at another, this being repeated over and over again. There is a little heat, but no pain, and desquamation rarely follows its subsidence.

Erythema circinatum and *marginatum* are degrees of the same form. In *E. circinatum* a number of small round patches form, which spread at their circumference while they fade in the centre, and by their intersections give rise to an appearance of a cluster of imperfect rings. Mr. Erasmus Wilson mentions a case in which the curves spread until the whole trunk and limbs had been occupied by them.

E. marginatum differs principally in the deeper congestion of the spots and rings; the colour approaches at times to purple, and the borders are more raised and defined. It is more frequently seen in elderly persons, and in connexion with disease of the internal organs.

E. papulatum is distinguished by the small size of the patches, which are at first of bright-red colour and a little raised; the spots become ultimately dark-coloured. A modification of this variety is *E. tuberculatum*, which is found more usually in debilitated persons, and is often ushered in by chills and fever. The spots are more elevated and persistent than in the papular form.

Erythema nodosum is usually seen in females of weakly and anæmic habit of body, and is not unfrequently associated with rheumatism; it appears in patches of tolerably uniform oval form, and sometimes two or three inches in diameter; the patches are elevated and have a tuberculated feel; they are painful and often very tender. Like the former variety, they are at first bright, but become in the course of a few days dark-coloured and livid, and then gradually fade, and are followed by desquamation of the cuticle. The eruption is always preceded by febrile symptoms, sometimes severe, and derangement of the digestive organs; these symptoms disappear as the eruption comes out.

The treatment of these varieties of symptomatic erythema must be guided by the general condition of system under which they appear. Where they depend on mere casual derangement of the digestive organs, mild saline purgatives and a regulated diet, with the occasional use of the tepid bath, or simple sponging of the skin with tepid water, will be all that is necessary. Tonics are often called for, as generally the disease occurs in persons of weakly habit or who are debilitated by disease.

Idiopathic erythema may be produced by any thing which irritates the skin, whether acting from within or without. Thus we have an erythematous state of skin from the distension of œdema in weak persons; *E. læve, œdematosum.* Here the skin has a uniformly shining transparent red appearance; it may continue long without change, and may then terminate in resolution, or ulceration or even mortification may take place. A long-continued depending position may produce it; and sometimes a similar inflammation may arise from internal derangement. The treatment consists of rest, position, cold lotion, and then gentle friction and the application of a wove bandage, with of course attention to the general state of the system.

E. intertrigo arises from friction of one part of the skin against another, or from the dress, or from the irritation of discharges; it is common in infants and in very fat persons. Chemical irritants and sun-burn produce the same, as will alternations of heat and cold, &c. Cleanliness, the removal of the cause, and weak lotion of lead, nitrate of silver, or corrosive sublimate, will generally suffice to remove it.

Erythema sometimes presents itself in a chronic form, especially on the face; it is often obstinate, depending on internal derangements, to which the attention must be directed in order to remove the disease. As a general rule, symptomatic erythema springs entirely from causes operating within the system, while erysipelas for the most part implies the concurrence of external and special influences.

We may now proceed with the consideration of the characters of erysipelas.

The inflammation, being the manifestation of a deeper-seated affection, probably of the blood, is, as would be expected, preceded by more or less of constitutional disturbance. This is sometimes so slight as to be unnoticed by the patient, and hence it has been supposed that the inflammation may occur without the general symptoms. This sometimes happens in true erysipelas; but in some cases where it has been supposed to occur, the skin-affection has been one of simple erythema. The most usual premonitory or accompanying constitutional symptoms are, a general feeling of indisposition, languor and chilliness, amounting at times to severe rigor. The skin is hot and dry; there is loss of appetite and thirst, with precordial pain; a bitter taste in the mouth, and eructations. The tongue from the first indicates the disorder of the digestive system. It is at first pale and flabby, and then becomes coated with a yellow creamy mucus. In the latter stages it becomes dry and brown and fissured. Sometimes the tongue passes at once to brown, though there is little or no previous fever; and this is frequently the case where dropsy is present. The bowels are almost always constipated, and when acted on, the motions are black and offensive. Occasionally, however, diarrhœa sets in from the first, the motions being offensive; and it is not unusual for relaxation of the bowels to occur towards the close in favourable cases. Where these symptoms of derangement of the digestive system are especially marked, and the countenance assumes a yellow hue, the term "bilious" has been applied to the erysipelas. The state of the urine, which should always be looked to, varies with the intensity of the febrile symptoms; sometimes it is but little altered, often it is high-coloured and scanty, depositing abundantly the amorphous lithates. The application of heat will, as in many febrile diseases, often produce a slight cloudiness from coagulated albumen; and in aggravated cases there will be frequently a very considerable amount of it, the result of temporary congestion of the kidney. This is most usually seen towards the termination of the inflammation, where desquamation is taking place; and at this time renal epithelium will often be found as well. But in a large number of cases there will be no appearance of albumen in the urine. Dr. Begbie finds that albuminurea is more frequently present in symptomatic than in traumatic erysipelas. The urine is almost always acid, and abounds in urea, but with a diminution of the chlorides. The pulse is quickened; sometimes it is full, soft, and compressible,—sometimes, and especially in fatal cases, irregular and intermittent. When the disease has advanced, it may become rapid, small, and weak; but often it remains large till the death of the patient, or the subsidence of the disease. It has been observed by Nunneley, and is confirmed by Mr. Hinckes Bird and others, that if the pulse rises in frequency after the sixth or seventh day, it is a very bad sign; this is generally true, though patients will at times recover in whom the quickening of the pulse at this period has been noticed. The blood drawn during the early stages generally shows the buffy coat. The blood-corpuscles are diminished in number, according to Andral and Gavarret; and Schönbein says that the serum is always tinged yellow by the colouring matter of the bile.* In erysipelas of the head there is often bleeding from the nose during the acute stage.

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* Simon's *Animal Chemistry;* Sydenham Soc. Translation, vol. i. p. 277.

The nervous system sometimes shows no further disturbance than the lassitude attendant on febrile action. Often, however, and especially in erysipelas of the head, there is, even in the earlier stages, aching and oppression in the head, drowsiness, or excitement amounting to delirium. In the latter stages of the more formidable cases of the disease, low muttering delirium and subsultus are present. The delirium does not usually at any period present the characters of active inflammation or excitement, but rather the type seen in low fever. Sometimes it resembles delirium tremens, the patient being readily recalled to consciousness when spoken to, but relapsing speedily into a wandering state. The excitement is, however, rarely so great as in delirium tremens. In the first instance, the wandering or delirium takes place generally only during the night, the consciousness returning during the daytime.

The temperature of the body is usually raised at first, but in advanced stages often falls below the natural standard.

Frank has pointed out a symptom which he regards as of great value in determining the advent of erysipelas of the head and face. Whenever, he says, the patient has had severe febrile symptoms for some hours, attended with pain, tenderness, and swelling of the lymphatic glands of the neck, he has no hesitation in determining that erysipelas is coming on. Chomel maintains the same view. It is denied by Velpeau, who regards the swelling as consequent upon, not as a precursor to, the inflammation. There is no doubt, however, that the neighbouring glands are very often tender before erysipelas of any part sets in. Mr. Busk, indeed, tells me that, after close observation of a large number of cases, he entertains no doubt of the invariable occurrence of affection of the glands before erysipelas appears, so as to constitute this a pathognomonic symptom. Hence it is his belief, that although the blood is diseased, the actual primary seat of the local inflammation is in the absorbent system.

If a wound or granulating surface exist, it takes on an altered action. The edges or surface become flabby, and covered with a thin serum instead of healthy pus. Granulations become pale, and are absorbed; parts tending to unite are disunited.

The seizure has been described as having in some cases been extremely sudden and violent. This has been noticed during the prevalence of violent epidemic erysipelas. It is reported of the late Sir George Beaumont, that he was at work after breakfast upon a picture, and fell down in a fainting-fit. Erysipelas presently showed itself on the head, and soon proved fatal.

The severity of the premonitory symptoms is not necessarily an indication of the severity of the erysipelas. They may be very violent, and the inflammation slight, and *vice versâ*. This seems to depend much on the temperament of the individual, and the greater or less tendency to constitutional reaction under partial derangement. The character of the symptoms, too, is modified by the same causes. One person will be restless and excited, another torpid; in one there may be violent rigors, in another scarcely a feeling of chilliness, though the inflammation developed may be the same in situation and intensity. The period that may elapse between the attack of febrile symptoms and the development of the local inflammation, is far from being a fixed one. It may vary from a few hours to three or four days, and in rare cases to even a longer time.

The local symptoms may be described under the principal forms of the disease in which they are developed, viz. of simple and phlegmonous erysipelas, and of diffuse cellular inflammation.

In its mildest form the inflammation resembles in all respects a simple erythema. The skin becomes of a diffused bright-red colour; it retains its usual pliancy, and there is no swelling to be either seen or felt, neither is there any vesication. The patient experiences a sensation of tingling and slight burning in the part. The constitutional symptoms are usually very slight, and the inflammation terminates after a day or two in resolution, followed perhaps by some desquamation of the cuticle. In its severer forms, simple erysipelas presents more definite characters. The skin becomes red, tense, and shining; frequently of a rose tint, whence the popular name; but the colour may vary from a reddish yellow to a deep livid red. The appearance of swelling may be at first very slight, but on passing the hand from the sound to the inflamed surface, a marked elevation of the latter will be noticed. The limits of the inflammation are, in general, sharply defined, the redness not merging insensibly into the natural colour of the skin, as is seen in phlegmon. A large portion of the skin may be attacked at once, and the inflammation has a tendency to spread widely in all directions; or in one direction especially; or it may be to break out in new patches, which extend and merge into one another, and into the part primarily affected. The parts newly invaded present the most characteristic appearances, as the disease is usually fading in those first attacked, while it is spreading to parts beyond. The redness disappears on pressure, and returns immediately on the pressure being removed. The skin has a more resisting feel than natural, and is hot to the touch. Very frequently miliary vesicles, or large bullæ, appear after the first few days, which burst and form incrustations; hence the terms *E. miliare* and *phlyctenodes.* The vesicles are usually filled with a transparent serum, changing afterwards to a straw-colour and becoming often semipurulent; in weakened states of the system, their contents have a deep purple colour. The pain is at first of a tingling and itching character, becoming afterwards more severe, burning, and smarting. But it is not constant, nor is it ever of the throbbing, wearing kind which exists in ordinary phlegmon. Often there is an almost entire absence of pain; but tenderness on pressure is always present.

The inflammation, though chiefly affecting the skin, is not limited to it. The areolar tissue beneath is more or less infiltrated with serum; so that, soon after the first invasion of the disease, considerable tumefaction takes place, and the skin becomes correspondingly tense and shining. When the face is the seat of the inflammation it becomes enormously swollen, so that the features are altogether obliterated.

Suppuration and gangrene do not generally result from this form of erysipelas; suppuration, however, occasionally takes place in small patches beneath the skin, especially in parts where the cellular tissue is lax; and gangrene may occur in persons whose systems have previously been much debilitated. The more usual course is, that the inflammation extends and retains its activity for three or four days, and then gradually declines, the swelling decreasing from the absorption of the serum, and the skin getting a somewhat shrivelled look and a deeper red colour. The whole passes off in from seven to ten days. When the redness and tension persist for a much longer period, a deeper-seated inflammation, with suppuration, may be suspected. Desquamation of the cuticle almost always follows the subsidence of the inflammation.

Simple erysipelas, unless it attack the head and face, or occur in persons already enfeebled by disease, is not of itself a formidable complaint. In the head and face it is dangerous, from the tendency to affection of the deeper-seated organs. Thus the membranes of the brain are often congested in consequence, it has been supposed, of direct communication of the disease from the external to the internal parts. But of this there is, in the majority of cases, little evidence. The congestion often arises, probably, from the pressure made by the swollen tissues of the face and neck on the veins returning blood from the head, the membranes being already in a partially congested state from the febrile condition attending the disease.

Occasionally cerebral excitement, like that of delirium tremens, takes place, and this even after the early and active state of the erysipelas of the head has subsided. This occurs usually in those who have habitually led irregular lives, and should be looked on perhaps as an accession of delirium tremens upon an attack of erysipelas.

Dr. Copland* mentions a case which occurred in the practice of Mr. Byam, and in which "the cellular tissue of the throat and of the whole neck was so distended, that the integuments appeared girt around them with the utmost tension; and in this instance the respiration and cough were as distinctly croupal as in idiopathic croup." Severe inflammation of the membrane of the fauces, and affecting the larynx, is another source of danger. It sometimes gives rise to that most dangerous condition, œdema of the glottis. In one of the cases recorded by Mr. Arnott,† death ensued from ulceration and sloughing at the back of the larynx. Although erysipelas did not make its appearance externally in this case, yet the attendant circumstance of two members of the family being seized with sore throat, accompanied by severe erysipelas, indicates that this may fairly be regarded as a case of suppressed erysipelas; of the same nature, pathologically, as the sore throat of suppressed scarlatina.

The congested state of the lungs, which is occasionally found to exist in these cases, depends no doubt on the impeded respiration, which is produced by the swollen mucous membranes.

These accidents occur most frequently in phlegmonous erysipelas; but they may take place in the more aggravated forms of the simple variety.

In œdematous erysipelas, the characters of the disease are considerably modified by the condition of the patient. It occurs in those of broken-down constitution, affected perhaps with serious organic disease, or reduced by previous illness. Instead of the usual bright rose-colour, the skin often presents a pale brownish or pale yellowish-red colour, and there is a strong disposition for it to run into gangrene. When this is imminent, the pain is greatly aggravated and the skin assumes a livid dark appearance. The cellular tissue becomes loaded with serum, and the affected part presents much of the character of advanced anasarca. Such cases are serious, not so much from the severity of the erysipelas, as from the low state of the vital powers of those in whom it is principally seen.

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* *Dictionary of Medicine*, art. "Erysipelas."

† *Medical and Physical Journal*, March 1857.

One or two forms may still be mentioned under which the inflammation at times appears. The disposition to spread from the point originally invaded is one of the distinctive characters of erysipelas. But this tendency is sometimes so strongly marked that the inflammation will be seen to spread over considerable parts of the body, those first affected having returned to their natural state (*E. ambulans*). In a case recorded by La Motte,* the inflammation began in the head and extended down the neck and shoulders, and so continued spreading downwards, the upper parts getting well, until no portion of the surface of the body had escaped, even down to the fingers and toes. M. Vidal† mentions another instance of rapid extension of the disease over the whole surface of the body. In other cases the inflammation will not spread continuously, but will invade distant parts, one after another, subsiding in one spot while it breaks out in another. To this form of erysipelas, which is strikingly illustrative of the alliance between it and the eruptive exanthemata, the term erratic (*E. erraticum*) has been applied.‡ The severer forms of erysipelas, such as the phlegmonous and œdematous, are rarely erratic; but this erratic tendency, though generally associated with the simple variety, is usually an indication of organic disease of the secreting organs, or of broken-down constitution. It is most frequently seen in connexion with erysipelas of the trunk, and is very rarely attended with vesication. The inflammation may appear slight and partake more of the characters of a simple erythema; but this form of the disease is never to be regarded without some apprehension.

The metastatic erysipelas, which has been described by many authors, is probably allied to this erratic form. In these cases, the inflammation suddenly recedes from the surface, and some internal organ, the lungs, or stomach, or intestines, are immediately affected.

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* See Cooper's *Surgical Dictionary*, art. "Erysipelas."

† *Médecine Opératoire*, vol. i. p. 147.

‡ In reference to this erratic tendency in erysipelas, Hunter says: "There appear to me two ways of accounting for this: one is, that the whole skin is very susceptible of such action, and readily goes on with it by continued sympathy; and the part having gone through the action, like the smallpox, &c., loses the disposition, and the action ceases. The other is, that the inflammation is such as to contaminate while it spreads; but when it has once acted, it is cured, as above observed." See Hunter's *Works*, Palmer's edition, vol. iii. p. 315.

This occurrence is, however, much more rare than is generally supposed. A few cases have certainly been recorded which seem to establish its possibility; but it is so uncommon that many of the best observers, with the greatest opportunities, have never met with an instance of it. It is not so unusual to find the serous membranes affected coincidently with the skin, or an inflammation occurring in them during the course of the disease, but without any disappearance of the erysipelas.

"Universal erysipelas," as it has been called, that is, where the whole surface of the body is attacked at once, not by spreading, must be extremely rare, if it ever occur. Mr. S. Cooper, in his *Surgical Dictionary*, mentions one such case, which was related to him by Mr. Maul of Southampton, but the details are not given. Another instance is related by M. Renaudin,[*] but somewhat vaguely. It occurred in a woman fifty years of age. "The entire skin of the trunk and limbs was slightly swollen, and was of an intense erysipelatous red colour; the face alone seemed to be less affected." It is possible that this may have been an instance of rapid erratic erysipelas.

The other great variety of erysipelas, the phlegmonous, into which, however, the simple form merges insensibly, is of a far more serious character. Simple erysipelas attacks principally the cutis, and the areolar and adipose tissues are affected only in a secondary and comparatively trifling manner; suppuration may indeed occur, but only in small patches and without death of the structures. But in phlegmonous erysipelas the subcutaneous tissues are involved as largely as the skin, and extensive suppuration and death of the structures involved is the more frequent termination. As in the inflammation of the skin, so in that of the areolar tissue, there is no tendency to limitation and circumscription by lymph; in this respect there is a striking contrast to true phlegmon. The skin itself, congested by the inflammation, and its nutrition interfered with by the destruction of the areolar tissue which supports and carries its vessels, falls largely into gangrene. The general constitutional symptoms which usher in and accompany the inflammation are more severe. In short, the whole phenomena and course of the disease show that more violent causes are in operation to produce it. Phlegmonous erysipelas is generally the consequence of wounds penetrating to the cellular tissue. It is in the head and in the extremities that the inflammation is seen in its most severe forms. In the former situation, however, destruction of the skin is much less frequent.

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[*] *Dictionnaire des Sciences Médicales.*

The general symptoms are, as has been stated, of the same nature as those seen in connexion with simple erysipelas, but usually present a more aggravated character. Dupuytren has pointed out that the febrile symptoms, although continued, are often marked by paroxysms and remissions, so that they have even been mistaken for those of intermittent fever. The signs of disorder of the digestive system are generally more prominent in phlegmonous than in simple erysipelas. Sometimes, however, the disease sets in mildly, both locally and generally, and gradually assumes a more serious character.

The inflammation may at first present much the same appearance as in the simple form, and there is often pain in the part for some hours before the fever manifests itself. Generally, however, the redness is deeper and has a more dusky hue, and the colour is not uniform; it is usually deeper at the centre than towards the circumference. The swelling is considerable, and pressure with the finger leaves a pit which does not immediately fill up, nor does the colour reappear directly upon the removal of the pressure. After a time the skin becomes so tense and hard that pitting under pressure can no longer be produced; the redness becomes deeper and often assumes a violet hue; small vesications and phlyctænæ are frequently but not always present; the pain is severe, burning, and often pulsating, and the general symptoms are aggravated; the urine is high-coloured and thick, its quantity is much diminished, and this amounts at times even to suppression; the tongue is thickly coated and yellow.

At this point, about the fifth or sixth day from the invasion of the inflammation, the symptoms often remain for a time stationary, or rather there is an appearance, but a fallacious one, of amendment. From having been hard and resisting, the skin becomes softer, it yields, and again pits under pressure. There is no sign of fluctuation, and the surgeon may be flattered with the hope that resolution is taking place. But the persistence, and often the aggravation of the general symptoms, and, as not unfrequently happens, a fresh attack of rigor, indicate that so far from there being amendment, this is really the period at which the most serious changes are taking place. The cellular tissue has become the seat of suppuration and death. No fluctuation can be perceived, for the pus or purulent serum, when it first forms, is diffused through the areolæ, or in thin layers, without any circumscribing boundary. In some situations, indeed, where the cellular tissue is abundant, as in the eyelids and face generally, the pus is found of good quality and in circumscribed cavities. Nor is the purulent secretion generally of an unhealthy character before sloughing of the tissue takes place, except in those whose general powers are much reduced, when it will be found to be thin and sanious.

If the disease be left to itself, the pus collects in larger quantities, separating the skin from its cellular membrane, and this from the fascia below, even throughout the entire limb, not forming a prominent swelling as in phlegmon, but in proportion as it forms burrowing farther and farther. The skin, thinned and detached, becomes livid, and ulcerates or sloughs. The phlyctænæ which may have formed burst, and show a dead patch of skin beneath them. The pus which escapes is fœtid, and shreds or layers of dead cellular tissue are found floating in it. From time to time large flakes of sloughy membrane, soaked in pus and often many inches in length, are discharged. The destruction of the skin proceeds, parts which hitherto have retained sensibility and colour fall into gangrene, and, in extreme cases, an entire limb may be denuded. Generally, however, in the midst of the loosened skin and sloughy cellular tissue, small bands covered with granulations may be seen connecting the skin with the fascia below. These, as Dupuytren has pointed out, should be carefully preserved; they mark situations in which the vessels and nerves have escaped the general destruction, and they serve as starting-points for reparative action.

In general the destructive action of the inflammation is limited by the fascia; but this is not always the case. Where the disease has been very violent, the fascia, the intermuscular septa, the sheaths of the vessels and of the tendons, and the tendons themselves, may become involved. Even the joints may be penetrated and rapidly destroyed, and the bones may be denuded of their periosteum and become necrosed. Under these circumstances the limb will probably be permanently disabled, even if preserved; and at the best it will be a very long time before the muscles can again be brought into use.

Up to what may be called the third stage of the erysipelas, that, namely, in which the hard brawny state of the skin has not given way to the soft quaggy condition, resolution may take place under active treatment; rarely, indeed, in the lower extremities, in which there is a strong disposition for the inflammation to run on to suppuration. And when suppuration has occurred, the formidable destruction which has been described may, by treatment, be limited or arrested.

The condition of the cellular tissue may often be seen in all its stages in fatal cases; for as the disease is progressive, some parts will be found in which only the earlier changes have taken place, while in others the destruction is complete. At first the tissue is congested and vascular, and its areolæ contain serum, which is occasionally tinged with blood. The serum becomes thicker, and is replaced by a semi-fluid, whitish, or often deep yellow matter. This is still lodged in the areolæ, and does not flow from them when cut into. By and by true pus appears, which, though still lodged in the cellules of the tissue, escapes when they are laid open. In the last stages the areolar tissue is found broken down, the pus is diffused in layers, and contains the fragments and shreds of cellular membrane.

The skin, where it has remained untouched by ulceration or mortification, loses after death its red colour, and appears shrivelled and brown. Its vascular tissue will be found congested, the veins especially being filled with dark thick blood. Pus and serum will be found in its areolæ; and exudations of a plastic kind, such as exist in carbuncle, &c. may be present. The cuticle readily peels off, and it seems as if a thin layer of serum lay between it and the corium.

The internal organs, in fatal cases of erysipelas, do not present any special characters. Almost always there will be some disease of liver, spleen,* or kidneys; often congestion of the mucous surfaces of the stomach and intestines; in short, such appearances as might be expected in persons of broken constitution, especially when caused by habitual intemperance. The principal morbid characters are found in the blood. In the early stages of the disease, it has much the appearance of ordinary inflammatory blood; the fibrine is abundant, and forms a marked buffy coat. But when the disease has passed beyond the active stage, and symptoms of depression have come on, the blood loses the disposition to separate, and forms a thin loose coagulum. Where death has occurred from the disease, the blood is sometimes thin and fluid, sometimes pitchy, often depositing a blackish powder. It stains the inner surface of the heart and great vessels, while the course of the superficial veins is tracked out by transudation. The corpuscles are much altered, broken up, and irregular. There are, then, sufficient indications that, as in typhoid and allied diseases, the blood is the principal seat of diseased action, which manifests itself in death and disintegration of the corpuscles.

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* The morbid states of spleen, so often found in connexion with erysipelas, are no doubt most frequently dependent on the altered condition of the blood in the later stages of the inflammation, and not on any preëxisting disease of the organ. The kidneys, too, will often be found congested in cases which present no evidence of previous disease of these organs.

The presence of pus-corpuscles in the blood of patients suffering under the most severe forms of erysipelas has been noticed by Dr. C. B. Williams,* and others. This may account for the frequent association of erysipelas with manifest pyæmia. Pus has not been always detected even in the worst and most prolonged cases of the disease.

A very important fact has, however, been mentioned to me by Mr. Busk, viz. that in all the fatal cases which he examined, the lungs were highly congested, and that on close inspection the smaller pulmonary vessels were always found to contain pus; that, in fact, a minor degree of pyæmia was always present. He has observed the same thing in the small veins of the head where that part has been the seat of erysipelas.

In those rarer cases in which destruction of the fasciæ and intermuscular cellular tissue has taken place, the muscles of the part are found black and soft. There is no evidence that they partake of the inflammatory action; their disorganisation probably depends on the destruction of the tissue which supports their vessels, which themselves are first blocked up and ultimately carried away in the general sloughing.

Associated with erysipelas in its causation and in many of the phenomena attending it, is a form of that disease which has attracted attention, in this country especially, under the name of "diffuse cellular inflammation." Although many cases of this disease had been described, its true nature was little recognised until the appearance of Dr. Andrew Duncan's paper in the first volume of the *Edinburgh Medical and Chirurgical Transactions*. This form of inflammation, which, it may be stated, in its general characters is identical with the cellulitis of phlegmonous erysipelas, arises from many causes. The cases to which Dr. Duncan drew attention were principally those caused by punctures made in venesection and in dissection; but the inflammation may follow any form of injury or surgical operation, or it may even take place without recognised injury, from the general condition of the patient or of the atmosphere. The disease is seen in its most intense form in those cases in which, as in dissection-wound, a septic poison is directly inoculated. Such cases will be more fully treated of under the head of ANIMAL POISONS. They must, however, be shortly noticed here in illustration of the general pathology of the erysipelatous affections.

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* *Principles of Medicine*, p. 313.

The diffuse inflammation of the cellular tissue is very frequently seen in connexion with absorbent inflammation and phlebitis, as well as with erysipelas; but it may occur independently of either. It may be supposed that they are in some degree allied in their nature, since they are so often seen to prevail at the same time and under similar circumstances. But there must be some cause in the system which modifies the action and determines the force which the inflammation shall take. After inoculation of the same morbid matter, one may be affected with diffuse cellulitis, another with inflamed absorbents, while on a third nothing will be manifested, perhaps, beyond an irritable state of the punctured part.

The general symptoms, when the disease takes place as a consequence of ordinary injury, are the same as are seen in erysipelas, and run the same course; but the tendency to collapse comes on earlier, and the whole course of the disease is more rapid. In the cellulitis which follows the inoculation of septic matter this is especially the case, and death ensues more distinctly from the general poisoning of the system than from the extent and severity of the local affection. The early symptoms may come on insidiously or may set in with violence, though even then there is usually a feeling of malaise preceding the attack. Profuse sweating is pretty constantly present. The prostration and excitement of the nervous system are more marked than in erysipelas; there is usually great agitation, and the delirium is often very violent. Pain is not at first referred to the seat of the inflammation, but is felt severely in the limbs, or back, or head, and more especially in the præcordium, and may move from part to part. Pain in the chest, and hurried embarrassed breathing, are present in those cases where the cellular tissue of the pectoral region is affected, as is so usually the case in dissection and bleeding wounds. The pulse is rapid from the first. The symptoms are indeed very like those of pyæmia, to which the disease is closely related.

The course of the inflammation of the cellular tissue is the same in both classes of the disease. But while after ordinary injury it spreads, like phlegmonous erysipelas, directly from the original seat of the injury, in cases of poisoned wound it attacks a remote part, between which and the puncture, in very many cases, no direct communication can be traced. In dissection-wound there is no doubt often inflammation of the absorbents and of the axillary glands; but this does not appear to be a necessary antecedent; it is often absent, or at any rate unnoticed, and is usually transient when it does occur. The puncture, too, may have entirely healed. The inflammation generally attacks the chest on the side which has received the wound, beginning in the neighbourhood of the axilla and spreading over the back and chest and abdomen down to the ilium, but rarely passing to the opposite side. It may, however, begin on the opposite side; or when it has commenced in the ordinary situation, may break out afresh in distant parts or spread across the chest. Often, too, in the course of the disease, patches of erysipelas, or maculæ, like those of typhus, may appear in various parts of the body. The extension of the inflammation to the pleura, mediastinum, or pericardium, is not uncommon.

The only difference between phlegmonous erysipelas and diffuse cellular inflammation is, that whereas in the former the skin and cellular tissue are attacked together, and from the same cause, or the affection of the cellular tissue is secondary to that of the skin, in the latter the cellular tissue is primarily involved, and the skin may be free entirely from inflammation, or it may occur merely as a result of the deeper-seated mischief. Hence phlegmonous erysipelas has an intermediate position between simple erysipelas, where the skin alone is affected, and diffuse cellulitis, in which the areolar tissue alone in involved. And this not merely in the order and occurrence of the phenomena, but in the relative severity of the disease. For while simple erysipelas is comparatively a harmless affection, diffuse cellular inflammation is, in proportion to its extent, more serious than phlegmonous erysipelas. However great may be the destruction of the cellular tissue, the skin, in most cases, is but little affected; indeed, it sometimes presents no trace of inflammation. The part is swollen and shining, very painful, and often exquisitely tender; but the pain and tenderness are due to the tense condition of the skin or to the nerves traversing the areolar tissue being involved in the inflammation, not to any inflammation in the skin itself. The swelling is diffused and uniform, not much elevated, and without a defined border. It is at first elastic and hard, but after a time becomes doughy. Occasionally there is crepitation, from the development of gases in the areolar tissue. These changes indicate that the inflammation has run on to suppuration and sloughing. Although the skin does not participate in the primary inflammation, yet there is often an erythematous blush on it indicative of the disease below. The absence of cutaneous inflammation is most marked in those cases which arise from poisoned wound, followed by distant cellulitis. Where the inflammation follows local injury without inoculation, and spreads from the injured part, the skin is more frequently affected. It assumes a pale-brownish, œdematous look, and towards the later stages may become livid, and be the seat of bullæ and vesications, and in some places even of sphacelation. It has been observed in some instances that the skin has been colder than natural; but this is by no means necessarily, nor is it perhaps even usually the case.

Resolution may occur, but it is much less frequent than in phlegmonous erysipelas. In the less severe cases healthy abscess may form; but almost invariably the suppuration is diffused, and death of the cellular tissue ensues.

The condition of the parts is the same as is seen in the subcutaneous tissue after phlegmonous erysipelas; but there is in general a greater disposition to deep suppuration and destruction of fasciæ, intermuscular aponeuroses, and sheaths of tendons. The deeper-seated layers of cellular tissue may become directly inflamed after injuries or operations. Operations on the sternum or neck are sometimes followed by diffuse inflammation in the mediastinum; and lithotomy, or division of fistula, by inflammation of the pelvic fasciæ or the areolar tissue about the rectum.

The inflammation may extend from affections of the throat in malignant scarlet fever, and may supervene in other parts at the termination of low fevers, especially when they are complicated with disease of the intestinal mucous membranes.

Death occurs in these cases, and especially after dissection or poisoned wound, more rapidly than in erysipelas. Some have terminated fatally as early as the fourth day from the receipt of the wound, and the eighth day seems to be about the average.

In thus bringing together under one head cases of diffuse cellular inflammation arising from dissection-wound and from ordinary injury or operation, it is not assumed that the poison which is in operation in the system to produce the symptoms is the same in both instances. The symptoms are the same, but so are those in snake-bites, where the poison is apparently of a specific nature. But it is not improbable that in all these, including erysipelas, the condition of the fluids of the body is really the same; and that though the morbid matters introduced may differ, they will act to produce a similar change in the blood. The intensity of the symptoms would depend on the degree of concentration of the poison, and the power of the system to resist its action. Chemico-pathology is more and more tending towards the old doctrine of fermentation, and indicates the rapidity with which albumen in certain states will induce changes in the animal fluids. And we have again abundant evidence of the rapid alteration which may take place in the whole mass of the blood under violent nervous impressions.

Causes. The question as to the essential cause of erysipelas is still involved in much obscurity. There is now no doubt that the inflammation depends on some morbid state of the system, probably beginning in the blood; which, as in the exanthemata and in typhoid fever, manifests itself in an altered local condition and in a general febrile action. Dr. Robert Williams, who objects to the notion that a morbid poison can be developed in the system, supposes that an erysipelatous virus is always more or less present in the atmosphere, ready to act on those who are capable of receiving it in consequence of a preëxisting unhealthy state of the system. It certainly cannot, like an ordinary inflammation, be produced at will by continued local irritation, however intense or prolonged, while in some the slightest local disturbance will excite it; and in such persons, as was pointed out by Hunter, "every inflammation, wherever it exists, will probably be of this kind." Be this as it may, there is no doubt that certain causes predispose to it; and that when the system is thus predisposed, it may arise apparently spontaneously, or from any local irritation.

The causes of erysipelas and of other similar constitutional disorders are usually divided into "predisposing" and "exciting." This division is not, however, sufficient to meet all the requirements of the case; and it is proposed here to distinguish them into *predisposing*, *exciting*, and *efficient* causes. The distinction between them may be thus illustrated. Two patients are admitted into the wards of a well-ventilated hospital, each having received a similar incised wound. The one is in perfect health, the other is suffering under derangement of the liver or kidneys. Supposing that no special cause of vitiation of the atmosphere is present, the wounds in both cases will heal; the one perhaps by the first intention, the other probably more slowly and with unhealthy action; but in neither will erysipelas be likely to occur. If, however, there be placed between these patients another, suffering under erysipelas, the first will probably still go on well, while the second will be attacked by the disease. Here the previous disease will predispose to the reception of the poison, and the wound will excite its action, while the emanation from the erysipelatous patient will be the efficient cause, without which neither of the two other states will be sufficient to induce the special inflammation. In the healthy subject, although an exciting and an efficient cause be present, the system will have strength enough to resist the influence of the miasm; the predisposing cause is absent.

Although in instances such as the foregoing the distinction between predisposing and efficient causes readily suggests itself, yet from our imperfect knowledge of the essential nature of erysipelas, it is not possible in a large number of cases to discriminate between them. An atmosphere tainted by imperfect ventilation, or by noxious effluvia, may possibly generate the poison, or may merely predispose to its reception.

With this reservation, we may consider bad ventilation, especially where the atmosphere is impregnated with any impure exhalation, as among the most common predisposing causes of erysipelas. Hence the frequency and severity of the disease in hospitals a quarter of a century ago, as compared with the present time. A remarkable instance of the truth of this is furnished by the Middlesex Hospital. Previous to the alteration of the hospital in 1858, the ventilation of the wards, but more especially of the passages leading to them, was extremely deficient, and erysipelas, with its allied diseases, pyæmia and diffuse cellular inflammation, were very common. The wards, for the most part, remain unaltered in size, and the position of the windows is the same, but they are on a better construction. The approaches and passages have, however, undergone a complete alteration, and are now thoroughly ventilated. Erysipelas, from being common, has become extremely rare, not more than ten or twelve cases occurring *in* the hospital in the course of the year, nor does the disease appear disposed to spread when cases are admitted. There are few metropolitan hospitals which cannot afford the same kind of evidence. Yet it does not appear that all kinds of vitiation of the atmosphere, however intense, will predispose to the disease. The houses in the neighbourhood of the Thames, for example, during the last two summers, have not been particularly visited by the disease, though exposed to emanations far from agreeable. The Crimean army medical report affords us another remarkable instance. Low fever abounded in the camp and the hospitals, where numbers of wounded were lying; the wounds took on various forms of unhealthy action, but erysipelas was almost entirely absent. Vitiated and unhealthy states of atmosphere, then, even when conjoined with circumstances which are generally most favourable to the reception of the disease, are not necessarily sufficient to induce its appearance. On the other hand, the atmosphere may be vitiated by causes so slight as to escape observation, and yet be abundantly productive of erysipelas. An instructive example of this was seen in one of the male accident-wards of the Middlesex Hospital a few years ago. It was observed that erysipelas commonly attacked the patients in two beds in particular, while it did not occur in any other patient in the ward or in the hospital generally. The constant repetition of this occurrence led to the conclusion that some special cause of vitiation of the atmosphere was in operation in the neighbourhood of these beds, and it appeared probable that the presence of a dustbin in the area below the window, on each side of which they were placed, must have had to do with the phenomenon. The dustbin was cleansed and whitewashed, its door was kept closed, and directions were given that the window should not be allowed to remain open. The erysipelas at once disappeared. A couple of years afterwards, the disease was again found to attack the patients in the same beds. It appeared that the precautions had been neglected, the dustbin had again become foul, and the door had been allowed to remain open. The adoption of the same measures again rendered the beds healthy, and they have since remained so. It may be remarked, that no unpleasant effluvium was detected in the neighbourhood of the window, which could lead to the impression that the atmosphere was in any way tainted. Here it cannot be determined whether the impure air merely predisposed the patients to take erysipelas, or whether the actual *materies morbi* was generated. The latter is, perhaps, the more probable view.

Exposure to cold and wet, improper or insufficient diet and habitual intemperance, predispose to the disease, partly by their general debilitating effect, partly by their inducing disease of the abdominal viscera, especially of the liver and kidneys. Indeed, derangement of the digestive and excreting organs, particularly diabetes and Bright's disease, must be ranked as amongst the foremost of the predisposing causes. Women suffering from amenorrhœa or dysmenorrhœa seem to be very liable to be attacked by it. Sometimes erysipelatous inflammation takes place periodically at the menstrual period. M. Costallat saw a woman who, during five menstrual periods, had erysipelas of the foot. The catamenia came on as soon as desquamation began.* This has been observed too by Hoffman. Patients recovering from dropsy and from fever are prone to it; but it is remarkable that those suffering from pulmonary disease are not very susceptible to its influence, and according to Dr. R. Williams phthisical patients are rarely affected. Powerful mental emotions, whether temporary or continued, are undoubted predisposing causes; and none more so than protracted anxiety,—perhaps from its influence on the digestive organs.

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* Vidal, *Médecine Opératoire*, vol. i. p. 150.

In some persons there seems to be a constitutional predisposition to erysipelas, the slightest causes inducing an attack of the inflammation. On what this state of system depends, is often obscure; it does not appear to be connected with the general health. The same proneness to special infection is seen in the case of many other diseases. It is observed, however, that this proneness to the disease is often connected with the rheumatic and gouty diathesis.

Exciting causes. Of the exciting causes the most frequent is perhaps local injury. Any kind of wound, even the simplest incised wound, any contusion, or fracture, or sprain, may excite the inflammation; but lacerated wounds of the extremities, and scalp-wounds, are its most fruitful sources. Fatal erysipelas has followed the mere removal of an atheromatous tumour of the scalp. But while the inflammation may follow the simplest wounds where every proper attention is paid to them, they become far more decided causes of it if irritated by improper applications or by friction, or if thorough cleanliness be not observed. The retention of an unhealthy purulent discharge by compression or bandages is a common mode of exciting erysipelas.

That erysipelas should follow an ordinary clean incision, without inoculation of a morbid material, and which yet would not have occurred unless some local injury had been inflicted, in no way supports the view that it is a mere modification of an ordinary inflammation. The same thing is seen in other diseases; in gout, for example, where an injury to a joint, or a contusion, or over-exertion, will often determine at once an attack in the part.

A current of cold air will excite the disease in the head; and it often follows the application of cold to the loins during menstruation, whereby the discharge is checked. A sudden chill, as by a person getting wet through, will cause it. Over-exertion will determine its appearance. Generally, however, in such cases there are co-existing circumstances favourable to the production of erysipelas; as long exposure to cold or wet, insufficient food, &c. This is often seen in the London hospitals in those who have walked from long distances in search of employment. But there is another and perhaps more decided cause in operation, namely, the vitiation of the blood itself by over-exertion. The observations of Duhamel, Haller, and

Chaussier show that in over-driven animals the blood becomes disorganised, and capable of producing gangrenous pustules and malignant fever when inoculated in healthy animals or in man.* And yet, as is seen from the Crimean army report, the fatigue to which the men were exposed, even when followed by severe wounds and confinement in hospital, did not give rise to erysipelas.

The scarification of parts affected with œdema, the legs and scrotum especially, is very apt to excite the disease, as are leech-bites and wounds made in venesection; and, when the predisposition is strong, even casual errors of diet. It is frequently seen in hospitals that patients who have received an injury which is going on favourably will be seized with sickness and shivering, and erysipelas will show itself. It will turn out that the mistaken kindness of friends has led them a day or two before to smuggle in some improper food, half-ripe fruit or pastry. In short, it would seem that any thing which produces a sudden derangement of the actions of a part, or of the whole system, may, under certain circumstances, determine an attack of erysipelas. In general, however, in order to induce phlegmonous erysipelas or diffuse cellular inflammation, the exciting cause must operate directly on the areolar tissue.

Efficient causes. Ignorant as we are at present as to the real nature and origin of any of the morbid poisons, it is impossible to distinguish accurately between the efficient and predisposing causes. Many of the foregoing may perhaps really belong to the present category. For example, some derangements of the digestive system may not merely put the body into a state favourable to the reception of erysipelatous infection, but may generate the poison of which the inflammation is the external expression. The commonly-observed fact that, in the wards of an hospital where patients are lying in various states of disease and with various injuries, one alone will be attacked with erysipelas, who has to all appearance been placed under the same circumstances as the rest, is no doubt favourable to the affirmative of this view. It is not conclusive, however; for, as is well known, abundant sources of contamination may be present, inappreciable perhaps and limited to a small space in a ward, as in the instance before mentioned.

The efficient causes may be considered under the heads of (*a*) general atmospheric condition, or epidemy; and (*b*) infection or contagion.

(*a*) It is a matter of common observation, that erysipelas is far more prevalent at one time than at another, and in one situation than another. But this tendency has often been present to so great an extent as to give to the disease the character of a severe epidemic. So far back as the time of Hippocrates this fact was observed. He has described an epidemic erysipelas, commencing in the spring and prolonged through the summer and autumn. In more recent times the records of such invasions have been very numerous. It does not appear that there is any one state of atmosphere in particular which tends to produce these epidemic forms. In some instances the season was cold and damp; in many others great heat and drought prevailed. Winter and summer have alike seen them. Generally, however, other epidemics were prevalent at the same time; and we may hence conclude that the atmosphere was unfitted to destroy the miasmata which were generated.

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* See on this subject Copland's *Dictionary*, art. "Blood," p. 192.

(*b*) While the existence of epidemic erysipelas is unquestioned, the infectious nature of the disease is by no means universally admitted. The French writers generally are opposed to such a notion, while it is received by most English authorities. The question is one of great practical importance. The possibility of producing the disease by direct inoculation from the vesicle may be put aside, resting as it does on the unconfirmed experiment of Willan. All hospital surgeons, however, are aware of the risk attending the indiscriminate use of sponges when erysipelas is present in a ward. It is seen that if a wound be cleansed with a sponge which has been used on an erysipelatous patient, the disease is pretty sure to appear in it. In many hospitals sponges are not, on this account, allowed to be used when erysipelas is present, and tow or cotton-wool are alone used for cleansing, and are at once thrown away. And this is a wise precaution. There is, indeed, no proof here that a specific virus is transferred from one patient to another. Those who deny the contagious nature of erysipelas not unreasonably assume that when the disease is prevalent it may be excited by any irritation, and especially by the application of impure animal matter to a wounded or ulcerating surface. The probability of the occurrence of direct infection in such cases will depend on the evidence of general infection by contact or by fomites. In the same way, the mere fact of the extension of erysipelas in a hospital or other limited locality, without direct contact, is no evidence *per se* of infection. It may, and perhaps most frequently does, depend on peculiar atmospheric conditions, the result of imperfect ventilation or unwholesome exhalations, which generate possibly the efficient, possibly only the predisposing, causes of the disease. It must be admitted that the disposition to the propagation of erysipelas by infection is not so great as is seen in the case of many diseases. But take the instances of scarlet fever, typhus, and typhoid fevers. Of the infectious character of the first no one entertains a doubt. Of that of the two others the evidence is incontrovertible, though it is denied by some; but, as Dr. Jenner points out, typhoid, though contagious, is infinitely less so than typhus. In erysipelas this character may be still less marked; but its existence rests on observations too striking and numerous to be set aside without the adoption of explanations far more difficult to receive than the simple one which the facts themselves suggest. And if it can be shown that, in many cases, the evidence of infection is just as strong, and rests on precisely the same grounds as in scarlet fever or typhus, it would surely be irrational to reject that evidence because it militates against a preconceived opinion, or to assign to accidental coincidence sequences of events often recurring and in a regular order.

The cases recorded by Dr. Wells,* Dr. Stevenson,† Mr. Arnott,‡ Mr. Lawrence,§ Dr. Elliotson, Mr. Erichsen,‖ and others, are too well known to require repetition here. They are too numerous and too striking to admit of any reasonable interpretation save that of the presence of disease of an infectious nature. Still it may be useful to put on record new and authentic instances; such as, amongst many others which have come to my knowledge, the two following. The first, which was under the observation of Dr. Rogers of Dean Street, resembles, save in its fatal termination, the case which Dr. Elliotson has mentioned as having occurred to himself. "A medical student went into the country, and was requested by his brother, a medical man, to visit an erysipelatous patient. Whilst leaning over her, he became conscious of a nauseous odour, which almost caused him to be sick. A few days after, he was suddenly seized with shivering, followed by fever; erysipelas shortly came on in the head and face, and he died after a week's illness."

In the second instance, which has been communicated to me by Dr. Goodfellow, as having been witnessed in the Fever Hospital, there seems every reason to think that the disease spread from bed to bed by infection. "In the epidemic of typhus that prevailed in the autumn of 1838, more or less of erysipelas was constantly to be found in the wards; and, as a general rule, it spread from bed to bed. On one occasion, however, this was more than usually striking. It occurred in the large fever-ward, containing thirteen beds, and well ventilated. Erysipelas attacked a patient on that side on which were seven beds. She was in the bed next but one to the end; the patient lying in the next bed, the third from the end, was next attacked, and then the patient at the end. The disease successively attacked all the patients in the order in which the beds were placed until it reached the lower end of the ward. It then attacked the patient lying at the same end of the ward, but on the opposite side, and spread from bed to bed until it reached the last on this side, the patient lying in which was the only one who escaped."

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* *Trans. of a Society for the Improvement of Med. and Chir. Knowledge*, vol. ii.

† *Trans. of the Medical and Chirurgical Soc. of Edinburgh*, vol. ii.

‡ *London Medical and Physical Journal*, March 1827.

§ *Medico-Chirurgical Trans.* vol. xiv.

‖ *Art and Science of Surgery*, 2d edition, pp. 36-8.

But the question of the identity in nature of erysipelas proper with many internal inflammations, which has been before alluded to, is one of even greater importance. At the present day, little doubt is entertained by British surgeons of the connexion, if not the identity, of this disease with puerperal fever. They both arise under the same circumstances, and the instances of their co-existence in the same patient, and of the tendency which each seems to possess to excite the other, are now so numerous, that it is next to impossible to resist the conclusion that puerperal fever is but an internal manifestation of erysipelas. And if so, the entire difficulty of receiving the view, that other internal membranes may be the seats of the disease, is removed. That they are far less frequently so than the peritoneum after childbirth, is only what we should expect. They can rarely be exposed to influences so favourable to the production of the disease. Cases such as the following, reported by Dr. Gibson,* tend to this conclusion: "An infant was attacked with erysipelas of one foot. The mother was soon afterwards seized with the disease in the head and face. The wet-nurse of the infant was taken with pneumonia, and was removed home, a distance of four miles. Her father, who had had an injury to the head, was soon afterwards seized with erysipelas of the scalp, and died; her sister had low fever, with sore throat; and two children in the same house were attacked with croup, and died." Dr. Warren† states broadly, "I have seen numbers of patients perish a few days after operations, at the time that erysipelas prevailed in the hospital, without the slightest external erythema. In such instances I have been in the habit of stating to you that these patients died of erysipelas as truly as if they had been covered with an erythematous eruption." Careful observation is still required on this point, the importance of which in regard to treatment can hardly be over-estimated.

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* *Trans. of Edinb. Med. and Chir. Soc.* vol. iii.

† *On Tumours*, p. 255.

Diagnosis. Erysipelas is little likely to be mistaken for any other disease. Its limitation to one part of the body, and the uniform character of the redness and absence of punctation where it is invading fresh portions of skin, and the absence (save in erysipelas of the head and face) of sore throat, distinguish it from scarlet fever. The first of Mr. Arnott's cases recorded in the *Medical and Physical Journal* might possibly, had it stood alone, have been mistaken for scarlatina maligna. In its severer forms, where there is œdema of the subcutaneous tissue, there is no sort of similarity between them.

Erythema has a greater disposition to appear in patches; there is no swelling, and the general symptoms are usually milder. There is no doubt, however, that under the name of erythema are often included cases of mild erysipelas. It could hardly be mistaken for pemphigus, or any other true vesicular disease. From phlegmon, the whole character of the inflammation and of the pain, its spreading character and the absence of prominent local swelling, the fever which ushers it in, and the absence of limitation, readily distinguish it. M. Vidal mentions a case in which malignant pustule was mistaken for erysipelas: this complaint, however, is little known in England.

Diffuse cellular inflammation is not always so readily distinguished from other diseases. It most resembles those with which it is most frequently associated, such as ordinary internal phlebitis, phlegmasia dolens, or inflamed absorbents. Where, as in a limb, the hard and tender veins can be traced, and the swelling is principally limited to their track, the distinction may be readily made; but when there is more diffused swelling, and the course of the veins cannot be traced, there may be at first some difficulty. In phlebitis, however, there is much less tendency to discoloration of the skin than even in cellulitis. The appearance of the limb and the early symptoms in intense absorbent inflammation sometimes resemble what is found in diffuse inflammation, and the two frequently coexist; but the red streaks and the extreme tenderness of the glands will point out the presence of the former. Extensive subfascial phlegmonous inflammation may produce rapid and general swelling of a limb, but the swelling soon becomes more localised and elevated; and the character of the pain and the attendant fever are unlike those of diffuse cellulitis.

Prognosis. So many attendant circumstances must be taken into account in estimating the probable results of an attack of erysipelas, that it is difficult to lay down any general rules for the guidance of the judgment. Each case will present its own special character.

The season, and the general or local state of the atmosphere; the age and constitution of the patient, his previous habits and the coexisting diseases; the exciting cause and mode of invasion, and the character and the situation of the inflammation, must be taken into account. The simple varieties uncomplicated with other disease will, if the patient be placed in a good atmosphere, run their course favourably, and terminate in resolution in from six to ten days. But under other circumstances they may pass into more serious forms, or may of themselves be not unattended with danger. When the disease is epidemic or endemic, no attack, however slight at first, is quite free from peril; and if at such times it supervene on wounds, the mortality is often great. In the very young and in the aged it is never without danger, nor in persons of cachectic habit, or whose constitution has been broken by previous disease or intemperance. When the disease attacks a dropsical limb, or comes on in the course of adynamic fever, it often proves fatal. In the former case, this depends rather on the cause of the dropsy than on the local condition, for there are no circumstances under which it is more dangerous than when the liver or kidneys are diseased. In a large majority of fatal cases in adults, when the erysipelas is not epidemic, it will be found that there is cirrhosis, or some other organic disease of the liver, or granular degeneration of the kidney. The presence of albumen in the urine, therefore, in the early stages of the disease, and in unvarying amount, must always excite grave apprehension, as must its presence at any period when accompanied by a low specific gravity. In the desquamative stage, as has been stated, albumen is often present in greater or less quantity, but disappears as the disease declines. When diabetes is present, the erysipelas is serious, and often fatal; and when the disease is erratic, or recurrent, or when it lingers on beyond the ordinary periods of resolution,—the pulse, instead of becoming slower, remaining quick or becoming accelerated,—a very guarded opinion should be given; such forms are frequently associated with internal organic mischief. It is principally in the two former varieties that metastasis to deep-seated parts is said to occur. This is, however, not a common event in any form of erysipelas; when it does take place, it is often fatal.

The more severe forms of the disease, phlegmonous erysipelas and diffuse cellular inflammation, usually occur after wounds; especially lacerated wounds, and those made in the great surgical operations. They are never unattended by danger, but the amount of danger will depend on the presence or absence of the conditions which have been just noticed. It is in the head and in the limbs that injuries most tend to excite the inflammation. In the head it is most specially liable to occur, both symptomatically and idiopathically, and should never be regarded otherwise than as a serious disease, from the disposition which exists to congestion of the membranes of the brain, and to spreading inflammation in the fauces and air-passages. Apart from this, the danger of these forms of erysipelas will be, *cæteris paribus*, in proportion rather to the extent to which the areolar tissue is involved, than to the severity of the inflammation; the affection of a whole limb will be more dangerous than a more limited though more intense inflammation. After all, it may be stated as a general proposition, that erysipelas is dangerous more from its association with other diseases than of itself.

While erysipelas is sometimes a serious disease, it not unfrequently has a salutary effect on a part or on the system. It often seems, like a fit of the gout, to clear away a long-standing condition of general indisposition. When the disease has passed off, the patient will be found to have regained elasticity of mind and body. And in the same way, when a part long affected with some chronic intractable disorder has been attacked, the disease will have often disappeared or have been much ameliorated on the subsidence of the inflammation.

Treatment. From the earliest times to the present day there have prevailed amongst practitioners two entirely opposite views with regard to the treatment of this disease in its earlier stages. According to the one, the disease, being essentially inflammatory in its character, should be treated according to the general rules laid down for the treatment of inflammation, by free bleeding and other antiphlogistic remedies. According to the other, the inflammation being the result of a lowered state of the system, a supporting and stimulating plan of treatment should at once be had recourse to. Each of these views has found among its supporters men of the highest authority and of the most extended experience. At the present day, indeed, the question no longer possesses the same interest as formerly attached to it. In this country, at least, extensive bleeding has in all cases fallen greatly into disuse; and in erysipelas especially, unless in very exceptional cases, is generally abandoned, though in France it has still its advocates. In investigating the records of this disease, one fact appears to be established, that whatever plan of treatment was formerly adopted, the inflammation ran a certain course with greater or less severity. What Dr. Watson says of erysipelas of the head and face is applicable, so far as the treatment by any of the plans formerly recommended is concerned, to all forms of the complaint: "I think the more you see of this disease, the more convinced you will be that it is not to be cut short by any particular mode of treatment; that it will run a certain course." And Velpeau and many others have expressed the same opinion.

Although, undoubtedly, the most satisfactory results have on the whole attended the treatment by support and stimulants, yet it can hardly be denied that the success of the opposite mode, even when carried to an extent which would now be considered by practitioners in this country as highly improper and dangerous, has been such as to render intelligible, if not to justify, its adoption by those who still employ it. Some even of those who advocated a stimulating treatment, only condemned that by depletion because the convalescence was thereby protracted; and the experience of Larrey has led him to conclude that it is safer in severe cases to treat on either plan than to leave the disease to run its own course. Nor is there any thing contradictory in this; for it must be remembered that at the present time bleeding is not borne in any disease as it formerly was, at least in this country. Neither is it altogether correct to call erysipelas, as is often done, a disease of debility, in the sense that all who are attacked by it are in a weakened or low state. That the disease, by its continuance, induces such a condition is undoubtedly true; but persons whose general powers are unimpaired may, from occasional and accidental causes, be placed in circumstances under which they may take the disease. In such cases the symptoms would run high, and the question might reasonably be entertained, whether a treatment calculated to diminish the intensity of the symptoms, and ward off the consequences which would follow their free development, would not be justifiable and even appropriate. From improved sanitary conditions, the efficient causes of erysipelas are not now so rife in this country as they formerly were, and those who are attacked by it are generally those who, by habitual intemperance or some continued predisposing cause, are very susceptible to its influence; those, that is to say, whose system is already below par. On the other hand, whatever may be at first the character of the symptoms, the disease sooner or later induces a state of system which demands support; and a wise forethought would lead to the practice of husbanding the patient's strength as far as possible. It is admitted, moreover, on all sides, that cases frequently arise in which depletion could not be thought of, and in which stimulants and support are required from the first; and such are the cases which now undoubtedly almost universally present themselves. There is one circumstance which should never be absent from the mind in considering the propriety of lowering the patient in any manner, and that is, the tendency which is often shown to sudden prostration, even when the disease has set in with high local and general action.

Whatever may be the mode of treatment adopted, there is one point which should never be neglected. Every means should be taken to ventilate the room properly; the bed-curtains should be removed, and the air should be freely admitted around the bed. If more than one be affected in the same house or ward of a hospital, they should be separated. These precautions should be taken, not only for the patient's sake, but in order to prevent as far as possible the risk of infection. If the erysipelas be in the head and face, of course it will be undesirable to allow a draft of air to fall on the patient, but it is equally, or even more important that the air should not be stagnant about him. When many are attacked in a ward, it is always well to empty it as soon as possible, to have the walls and ceilings washed, and to ventilate it thoroughly.

It is hardly necessary, in a treatise like the present, to enter at large upon the various means of internal treatment which have been applied to this disease. The general principles of therapeutics, as applicable either to simple inflammation or to common or specific fevers, have of course been brought to bear upon it. It is clear that, apart from the question of the possibility of attacking the specific cause, no general rule can be laid down which shall apply to a disease which sometimes creates merely a transient febrile condition, at others sets in with a violence almost equal to that of the plague; which is at one time accompanied by high action, at another prostrates at once the vital powers. Each case must be treated to a certain extent according to the condition of the patient and the character of the attack.

There are certain indications which should never be neglected. It has been seen that the bowels are generally torpid, though sometimes diarrhœa takes place. In either case the evacuations are unhealthy. When there is constipation, and the bowels have been acted on by purgatives, the motions are usually pitchy and very offensive. When diarrhœa is present, the motions, though fluid, have otherwise much the same character, and are dark-coloured and offensive. In order to give full effect to any treatment, it is well that these states should be corrected; and few cases occur in which the action of mercury in the first instance is not beneficial. In the more usual torpid states of the bowels, brisk purgation with calomel and jalap or scammony, followed up if necessary by a warm aperient draught, so that natural bilious motions may be obtained, will seldom fail to improve the state of the patient, and will always allow wine and tonics to be given with greater advantage. Even in more advanced cases, when the patient is in a state of prostration, with a dry tongue and weak pulse, if this point has not been previously attended to, his condition will be often found to improve under the action of the medicine, though of course wine and support should be given at the same time; and where the disease sets in with diarrhœa, gray powder with soda three or four times a day will generally be found beneficial. The same medicine may be given advantageously when, after the bowels have been acted on by calomel, the motions still retain an unhealthy character. In the minor cases, saline medicines, with small doses of sulphate of magnesia, and in some very slight ones mere attention to diet, will be all that is needed. The condition of the bowels is disregarded by some surgeons; and in many cases no doubt the disease will run its course, and the patient recover, where no attention is paid to this point. But often the same treatment will induce a feverish state before the liver has been unloaded, which afterwards will act most favourably; and it certainly seems consistent with reason, as I believe it is with experience, that that condition which is amongst the most frequent in predisposing to the disease, should so far as possible be removed. Many cases will of course occur in which the judgment of the practitioner will lead him to be more cautious in the use of calomel. Where the erysipelas, for example, appears at the termination of, or associated with, other diseases, such as fever, or dropsy with organic affection of the liver or kidney, active purgation will not be well borne; but even in such cases the use of the milder mercurial preparations will often be advantageous, while support and wine are allowed at the same time. When the derangement of the digestive system has been, as far as may be, removed, quinine, or cinchona, or calumba, will be found useful, though before they may have had the effect of making the patient more feverish.

With the exception, perhaps, of the tincture of the sesquichloride of iron, our chief trust should be in port-wine or spirits and beef-tea. The quantity of wine which it may be desirable to allow must depend very much on the previous habit of the patient, as well as on the character of the symptoms. Generally about six ounces a day, if this treatment has been commenced early, will suffice; but in those habituated to free living, or when the supporting plan has not been resorted to until the symptoms of depression have come on, much more will be required. The effects of stimulants must be carefully watched. When they are found to produce dryness and heat of skin, with increase of restlessness or torpor, it is a sign that they have been carried further than is good, and a longer interval should elapse before they are repeated.

With regard to nourishment, a pint or two of beef-tea, and one or two cups of arrowroot or sago, will in general be all that is required. The stomach is not in a state to digest much, and great care should be taken not to overload it. The sensations of the patient are very valuable guides in this matter. If there be a loathing of food or a tendency to sickness, it is of no use, and will often do much harm, to force nourishment upon him. The wine rarely disagrees, and is as rarely objected to.

Towards the later stages of the disease, if the patient be found in a state of low wandering, with a weak quick pulse, a rough dry tongue, and a cold skin, good bottled stout will be often the best medicine. Patients will be often seen to drink a tumbler or two of it with eagerness, when they have objected to other things, and then to fall into a tranquil sleep; the skin will become warm, and bedewed with a comfortable moisture, and the symptoms on their awaking will be all ameliorated. Instead of wine or stout, it may be often better, in any stage, to give the stimulant to which the patient has been accustomed, especially if he show any marked preference for it.

It is not a little remarkable that, among the numerous medicines which have been tried in erysipelas, that class alone which seems to exercise any really controlling power over the disease should not have had a recognised place till within the last few years, viz. the ferruginous preparations. This is the more remarkable because Velpeau, so far back as the year 1841, emphatically pointed out the advantage to be derived from their external use in simple erysipelas (*E. légitime*). In his *Leçons Orales*, speaking of the failure of other remedies, he says that he was led to try the sulphate of iron, and adds: "It modifies, it changes very positively the erysipelatous inflammation; I do not say that it extinguishes it as soon as it is in contact with it; but it is certain that it sensibly shortens its duration, and that an erysipelatous patch does not resist the application of the sulphate of iron for more than two or three days. Treated by this remedy, an ordinary erysipelas, where there is a succession of patches of inflammation, never lasts more than three to six days, whereas the average duration of the disease is not less than twelve days."*

The internal use of iron, in the form of the muriated tincture, had, however, been largely and successfully tried by Dr. G. Hamilton Bell for many years before this date; but it was not until 1851 that the results of his experience were made public in a paper read before the Medico-Chirurgical Society of Edinburgh. Since then the remedy has been getting gradually into general use, and daily experience shows that its value has hardly been overrated by Dr. Bell. The rationale of its action advanced by Dr. Bell is more questionable. He believes that the beneficial influence of the medicine is due to its controlling power over the tonicity of the capillaries of the inflamed part. That it is useful as a general tonic is very probable; but its peculiar action on the disease, controlling and rapidly cutting it short in a manner effected by no other tonic, seems to indicate that it strikes more at the root of the disease itself; and that its principal effect is on the blood, as was suggested by Velpeau. The opinion given by Dr. Balfour is pretty generally borne out by the experience of those who have given the medicine a fair trial, "that we now possess a certain and unfailing remedy, whether the erysipelas be infantile or adult, idiopathic or traumatic."† It is certainly supported by all that has been seen of the effects of the remedy in the wards of the Middlesex Hospital, where for many years hardly any other treatment has been in use. For the most part, the cases in which it has failed have been those in which there has existed extensive organic disease of the liver or kidneys.

Of course it is not asserted that cases may not occur now and then in which the iron will appear to be inert. Indeed I have met with some cases in which, although to all appearance very favourable for the use of the iron, it has had no marked effect in controlling the disease, which has run its usual course. It has appeared to me, nevertheless, that in some of these the constitutional symptoms bore no proportion to the severity of the inflammation. But that it will do, in the majority of cases, what no medicine of any other class has yet been found to do, namely, cut short the disease, no one, I believe, who has fairly tried it will deny. In the records of failure, it is evident that often the medicine has not been fully tried. In a recently published lecture by Dr. Parkes, for example, he expresses the opinion from his own experience that the iron exerts no power over the disease. In one of the cases, however, ten drops were given three times a day; in another, three drachms were taken in all. In quantities such as these the iron is inert, or at least the effects are too slight to be appreciable. Less than a drachm and a half to two drachms a day will rarely in adults produce much effect. In severe cases, an ounce and a half to two ounces a day will often be required. The evidence of its effects rests on this: treated in the ordinary way, erysipelas, as a rule, runs a course of from seven to ten days at the least; treated by the iron, it often subsides in from the second to the fourth day. There are, however, certain precautions, the neglect of which will often render the remedy inoperative or actually injurious. It should never be given so long as the secretions of the liver and bowels are in the unhealthy state which almost always accompanies the early stages of erysipelas. In such cases, the free administration of calomel, followed by warm saline purgatives, is especially called for; nor need the advanced state of the disease, nor the lowness of the patient, interfere with this treatment, if it have not been previously adopted. Even when increased cerebral excitement attends the administration of the medicine, there is no need to discontinue its use. This is sometimes the case; but it will be found that in general the disturbance will subside after a short time, though the iron be still given, as was pointed out by Dr. Bell. The quantity of the tincture which may be required will depend on the severity of the symptoms. In advanced and serious cases, as much as half a drachm may be given every hour; in slighter ones, fifteen to twenty minims every four hours will suffice.

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* Op. cit. p. 307.

† *Monthly Journal;* 1853.

Of the symptoms which arise in the course of an attack of erysipelas, those which belong to affections of the nervous system are among the most important. They may proceed from vascular excitement, amounting to inflammation of the membranes of the brain, or from congestion, or from the circulation of an impure blood, or from exhaustion of the nervous system. Inflammation is rarely present, unless as a consequence of severe erysipelas of the head. But it must be regarded as itself of an erysipelatous nature, and its treatment must therefore be guided by the general principles which apply to the treatment of erysipelas. It is here, if any where, that bleeding may be properly resorted to. For from the tendency which there is for effusion to take place, it is highly important to lessen as early as possible the vascular action. Should it be thought necessary to take blood, it should be done early, and once for all. But it should be done cautiously, by leeches to the temples, or by small incisions into the inflamed pericranium; and the bleeding should be arrested as soon as an effect has been produced on the pulse. It is only in the young and plethoric, however, and very rarely amongst the patients in a London hospital, that bleeding is called for. Free purgation, and the use of turpentine enemata, will be in most cases useful. And when the liver and bowels have been largely unloaded, the iron may be safely given, and will act as in other states of the disease. Wine, too, may be allowed, but its effects must be very carefully watched. When coma has come on after marked inflammatory symptoms, with a rapid pulse and thickly-coated, black, dry tongue, the case is one of the most serious character. Dr. Copland says, that he has seen the most marked benefit from the use of calomel, in a full dose, with camphor, followed by turpentine and castor-oil in the form of an electuary, to be placed on the back of the tongue, and repeated until the bowels begin to act, when its operation may be promoted by enemata, blisters being applied to the nape of the neck or insides of the thighs. Copious offensive black motions are generally brought away, with marked amelioration of the symptoms. This mode of treatment, followed by the free use of the tincture of iron and of wine, will I believe be effective in apparently hopeless cases.

In the other forms of affection of the nervous system bleeding is never admissible. The general treatment which has been recommended will, in most cases, be all that is required to allay the nervous symptoms. Sometimes, however, they demand special attention. For example, we not unfrequently see cases in which the nervous excitement and restless wakefulness are greatly in excess of the general symptoms of the erysipelas, and tend to exhaust the patient. This has been observed often in connexion with erratic, and it is said with metastatic, erysipelas. In such cases morphia or henbane are often of great use; but they should be given very cautiously if there be evidence of the existence of organic disease of the liver or kidneys. As a general rule, indeed, narcotics are not well borne in erysipelas, and tend to cause a dry tongue and congestion of the brain. Under no circumstances should they be given until the bowels have been freely relieved. Camphor, on the other hand, whether wandering or torpor be present, seems to act favourably; and may be freely given when nervous symptoms, and especially those which occur in the later stages of the disease, are marked. Another and a valuable remedy is ammonia. The cases to which it seems most appropriate are those also in which nervous prostration or excitement are especially prominent; where, for example, the inflammation being of the simple kind, the skin remains soft and not burning, or perhaps cold; where the tongue is moist and flabby, and the pulse quick, large, and weak, while there is great restlessness, or transient delirium, or nervous prostration. But where the tongue is hard and dry and fissured, and the skin is hot and dry, ammonia does not appear to me to agree so well.

While, then, at the outset of the disease, whether simple or phlegmonous, the intensity of the symptoms may now and then indicate the propriety of a moderate antiphlogistic treatment; as a general rule, and at all times where the disease has made progress, a tonic and supporting treatment is called for. And of the tonics which have been used, there is a preponderating evidence in favour of the sesquichloride of iron,* as having a power which others do not possess of arresting the course of the inflammation during all periods.

With regard to the general treatment of diffuse cellular inflammation arising from injury or operation, with or without the inoculation of a morbid poison, there is now little difference amongst surgeons. On all hands the depleting treatment is condemned, and the free and early use of tonics and stimulants recommended. Our chief dependence must be on wine, spirits, or stout, with camphor and henbane, or perhaps opium, to allay the irritable condition of the nervous system and diminish the pain. It may be presumed that the iron remedy will act favourably in such cases, as they are in their nature the same as erysipelas. I have not, however, had any personal experience of its effects.

The local treatment of simple erysipelas and of the early periods of phlegmonous erysipelas must be considered with reference to its effect on the local inflammation and on the disease generally. The suggestion of Hunter, that the inflammation contaminates while it spreads, is one which has perhaps not received all the attention which it deserves. The inflammation is the expression of a diseased state of the fluids; of what nature, is still a question. It may be the elimination of a poison, or a result of altered nutrition or of altered nervous action. One thing is clear, that the products of the inflammation are of a morbid nature, capable of producing the disease in those who are predisposed to it, and at the part at which they are introduced. Hence may arise the disposition, so remarkable in erysipelas, to spread from the point first invaded. But opposed to this disposition there is the tendency to elimination which exists in the exanthemata, and indeed in disease generally, if the system be sustained in a state of vigour sufficient to enable it to throw off the disease. To a certain extent, then, the local inflammation may be regarded as reacting on the general disease, and any thing which would check the local action would so far tend to the removal of the disease generally; just as in smallpox the severity of the attack is greatly modified by rendering the pustules abortive.

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* The perchloride has been lately recommended by M. Mathey, not only for the inflammation when it exists, but as a prophylactic after operations, &c., when the disease is epidemic. The effect is precisely the same as that of the sesquichloride, when the latter is given in sufficiently full doses.

It is only on some such assumption that the apparently contradictory facts can be reconciled, viz. that the disease itself is general, the inflammation being only its external manifestation, and that the removal of that external manifestation will aid in curing the disease.

The observations by Velpeau on the effect of the local application of the sulphate of iron have been verified by others. Mr. Luke informs me that, according to his experience, the collodion treatment often cuts short the disease; nay, even mere position has some influence in arresting its course.

But though these and other measures are beneficial, and at times perhaps effectual in removing the disease, yet cases constantly occur in which they exercise no actual control over it; the disease has too great a hold, or the vital powers are too low, to allow of its arrest by such measures. Nor should they under any circumstances be trusted to alone. Combined with other treatment, they become valuable coefficients.

The sulphate of iron, either in a lotion or ointment, produces, as has been said, a decided effect on the inflammation, and tends to shorten the disease. In lotion, a drachm of the salt to a pint of water; in ointment, a scruple to an ounce of lard, may be used. Its effect is very speedy and marked; the redness and tension subsiding, and, if freely applied, the disposition to spread being in some measure checked. But it is an inconvenient remedy, from its soiling the linen with which it comes in contact. The efficacy of collodion in arresting erysipelas is not fully determined. That it is a most useful application is admitted by all. It was, I believe, first used in this affection by Mr. Busk, and is now extensively employed both here and abroad. By Mr. Luke, whose opportunities of testing its efficacy in the London Hospital are very extensive, it is regarded as having an arresting influence over the disease. In a communication which he was good enough to make to me, Mr. Luke informed me that he had abundant reason for believing that the course of the disease might be cut short by the careful and free use of collodion. Mr. Busk, however, attributes to it only a palliative influence. There is no doubt whatever that it forms an uniform and unirritating protection to the sensitive skin; and besides this, it is probable that it acts directly on the inflammation, its equal pressure when contracted emptying and supporting the congested vessels. Even when the collodion has been applied well beyond the limits of the redness, and the parts beneath it have been rendered pale, the inflammation is often found to continue its spread and pass beyond. It is probable, however, that by checking the intensity of the local inflammation, it may tend to check the severity of the general disorder.

Another agent for which the property of controlling the disease has been claimed, is tincture of iodine, which was recommended by Mr. Norris,* who believes that the effect is not merely local, but that "it exhibits a marked control over the constitutional symptoms." I do not know whether this remedy has been employed by others. If it really exercises any influence over the local and general symptoms, it would be well to try the effect of iodised collodion, which is at times beneficially employed in strumous affections.

An application still frequently used, though with very uncertain results, is the nitrate of silver, first recommended by Mr. Higginbottom of Nottingham.† He applied the stick of caustic over the whole inflamed part, and to the distance of an inch or two over the sound skin beyond, the parts having been previously well cleansed and then slightly moistened. The extent to which the caustic was made to affect the skin depended on the severity of the inflammation. Solutions of the salt, varying in strength according to the amount of action required, have also been used. But the mode of application now generally adopted, especially in erysipelas of the limbs, is the formation of a line a few inches above the inflamed part, completely surrounding the limb. Care must be taken that no part of the circle be left untouched. The inflammation will come up to this line, and there in many cases stop; or if the ring be imperfect, will insinuate itself through the opening, and then spread beyond. But there is a great difference of opinion as to the dependence to be placed on this treatment. I cannot say that I have found it effective in nine cases out of ten. In a large number of cases it has appeared to me inoperative, the inflammation passing the line of demarcation, and sometimes even a second and a third line. At other times, however, the inflammation has been arrested. The plan is so simple that it might be well to adopt it in any case, in conjunction with the collodion, or iron, or other application to the inflamed part.

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* *Medical Times and Gazette*, Dec. 1852.

† An essay on the *Use of Nitrate of Silver in the Cure of Inflammation, Wounds, and Ulcers.*

Whatever application may be made to the inflamed part, attention should be paid to position. If the inflammation be in the limbs, they should be elevated; the leg, for example, should be kept in the position which would be maintained in fractured patella. This alone will often give marked relief, diminishing action and relieving congestion.

There are not many things which are more comfortable to the patient than a thick layer of cotton-wool placed over the part, which may be previously powdered with flour, or may have any of the forenamed applications applied to it. Generally it is more soothing than fomentations, and requires far less attention and exposure. Fomentations, however, when the inflammatory action runs very high, are often desirable, and chamomile or hops will add to their efficacy. I have found benefit from the addition of arnica to fomentations and local baths. Cold lotions should never be employed; they may indeed check the local action, but with a tendency to invasion of the disease in other situations.

The application of leeches in the early stage, of blisters, of the actual cautery, and of mercurial ointment, has been recommended, and they have all been largely tried. There is no evidence that they have any real effect on the disease, and they are generally abandoned in this country, though still used in France. The objection which exists against general bleeding may be urged against any such amount of local bleeding as would really diminish the action of the part; and unless they are freely applied, they only irritate. Counter-irritation, whether by blisters or the hot iron, does not appear to have shortened the duration of the disease in any case; nor is there any evidence that it has been productive of any other benefit. The same remark applies to mercurial ointment, which has the further disadvantage that it generally salivates profusely.

The local treatment of phlegmonous erysipelas does not differ in its earliest stages from that of the simple forms. The advocates for depletion of course recommend that more decided antiphlogistic means should be used, and that blood should be taken freely from the part by leeches, cupping, or incision. The two former methods are now little employed, and are rarely productive of any good. The practice of making incisions is one of long standing; and considering the high vascular action and great tension which are present, is one which, it might be supposed, would naturally suggest itself to the surgeon. According to Velpeau, they have long been practised in Russia, and amongst the peasants in Brittany. Modern surgery is indebted, however, to Dr. Copland Hutchison* for their introduction to the notice of the profession. The plan, which from the year 1814 Dr. Hutchison had adopted largely in naval practice, consisted in making incisions of from an inch to an inch and a half in length, and two or three inches apart, in a longitudinal direction, through the affected limb. Their depth varied according to the nature of the inflammation. In general they reached the fascia, but extended through it when the inflammation extended to the deeper tissues. From fifteen to twenty ounces of blood were usually lost from the overloaded vessels. The hæmorrhage was controlled as far as is possible; a little pressure, with attention to position, generally effected this; the limb was then fomented. The obvious effect of these incisions is to relieve the tension of the skin, to allow of the escape of the accumulated serum and pus where it is formed, and hence to diminish the risk of sloughing of the cellular tissue, and of extension of the suppuration. As phlegmonous erysipelas will often, under proper treatment, end in resolution, it is not necessary to resort at once to incisions; but when the skin is becoming brawny, and it is clear that suppuration is threatened, they should be made at once. Still more important is it to have recourse to them, when that softening occurs which has been before described as indicating that the cellular tissue has fallen into suppuration. Instead of these small incisions, Mr. Lawrence recommended one long incision extending longitudinally through the whole length of the inflamed part, and thus at times reaching from one end of a limb to the other. This plan is now, however, generally abandoned; the amount of hæmorrhage was in some cases so great as to prove fatal. Nor is the relief afforded to the congested tissues greater than when the safer and milder treatment by multiple incision is adopted.

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* *Med.-Chir. Trans.* vol. v.

The practice of scarification, recommended by many of the older surgeons, was again brought into notice by Sir Richard Dobson,* who used it in all forms of erysipelas. It consists in making numerous punctures, varying in number according to the extent of the disease, from ten to fifty, and in size from one to two-fifths of an inch. They were repeated twice a day in moderate cases, and three or four times a day in severe ones. According to Sir R. Dobson, only two cases were lost out of many hundreds treated in this way. No doubt, if used early, these punctures will often prove sufficient; but if the indications of commencing suppuration be present, it is better at once to have recourse to the small incisions.

When the boggy feel in the part indicates that suppuration has advanced to destruction of tissue, incisions must be freely made, and collections of matter must be at once let out. The suppuration will be abundant, and the dressings must be often changed and the parts cleansed. Shreds and flakes of sloughy membrane should be gently drawn away, and it will save time if the skin, which is thinned and blue, and evidently unfit to take on healthy action, is at once removed; but every point of skin or subcutaneous tissue which retains its proper vitality should be carefully husbanded.

It is better to avoid poulticing, which tends to keep up a profuse suppuration. The part should be supported with perforated lint or linen, outside which should be a layer of cotton-wool, and the whole surrounded with a bandage. When the action of the part begins to flag, stimulant washes may be used, or the lint covered with the basilicon ointment. Where the granulating surface is very extensive, the cicatrisation will go on well to a certain point, and then the process may become arrested, and the modes of treatment required in indolent ulcers must be put in force. It is well to protect the edges with collodion and oil. Great benefit will often be found where the suppuration is foul in the use of weak solutions of Condy's fluid applied as water-dressing.

The patient's strength must be freely supported, and every thing done which will tend to the improvement of his general health.

Nothing can be more contradictory than the statements which have been made with respect to the effect of compression in erysipelas. It was employed by the older surgeons, as Paré, with success; but had fallen into oblivion when Velpeau, in 1826, again brought it into notice. At first he employed it in all forms of the disease, but ultimately he came to the conclusion that, while if employed at the right time and in the proper manner, it was almost a certain means of arresting phlegmonous erysipelas, it had no effect on the simple forms. He says* that when the phlegmonous erysipelas is only of three days' duration, compression will almost always produce resolution; and that it is still useful even when pus has formed and the cellular tissue has become mortified. Perhaps the compressive bandage has not been so well applied by others, but certain it is that it has not been generally found so efficient as to bring it into general use. The roller should be so applied as to produce moderate but uniform pressure, and should be reapplied every twenty-four hours or less, according to the effect it has in diminishing the swelling. The pressure produced by collodion is more uniform and sufficiently firm; any benefit, then, which can be derived from compression will be more easily obtained by its use than by that of the bandage.

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* *Med.-Chir. Trans.* vol. xiv.

Generally, then, it may be stated, that in the early stages of phlegmonous erysipelas, in the course of the first two or three days, attempts may be made to arrest the course of the inflammation by the means which are found most effective in the simple forms,—such as the use of collodion, of iron, or of the compressive bandage. Should these not be found of any avail in checking it, incisions should be at once resorted to freely and decisively; and they should be resorted to afterwards wherever it may be found that pus is lodged, or that the cellular tissue has been destroyed in parts removed from the neighbourhood of those previously made.

The treatment of diffuse cellular inflammation is much the same as that of phlegmonous erysipelas, but it must be more prompt. The chances of resolution are far less, and we have no guide in the skin as to the state of the parts beneath. It is well so soon as there is evidence that the disease exists, to make incisions at once; but of course hæmorrhage must be carefully checked. The after-treatment must be the same as in the phlegmonous form. Care must be taken that, while the dead tissue has free exit, those parts in which vitality still remains are carefully preserved. Perforated lint spread with basilicon ointment should then be laid over the limb, and surrounded and supported by cotton-wool and bandage, which must be changed as often as the amount of suppuration calls for it.

CAMPBELL DE MORGAN.

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* *Leçons orales de Clinique Chirurgicale,* vol. iii. p. 271.

LEEDS SCHOOL OF MEDICINE

PYÆMIA.

PYÆMIA has attracted considerable attention in connexion with a condition of veins known as phlebitis, and the expression has now obtained general usage as indicating conveniently, though incorrectly, blood altered throughout the system by the action of certain animal products. For a time, many observers associated it with other changes. Some, following Desault, ascribed it to a disturbance of the nervous centres; others considered it as primarily an affection of the lymphatic system; whilst some have written of its occurrence as dependent at certain times upon occult atmospheric causes.

But many writers confuse two diseases under the name of pyæmia, or puriform infection; one, the *primary* or direct consequence of a poison, in which fluid elements are, it is probable, chiefly concerned; the other, a *secondary complication*, but in itself distinct and often independent. By regarding the two as interdependent, authors have differed much in their explanation of the secondary complication to which the term *pyæmia* especially applies.

Animal or septic poison, introduced into the system, is the *exciting cause* of the primary disease, *systemic infection.* In no case, however, is its nature detected, far less the cause of its peculiar action, any more than that of the virus of smallpox, syphilis, and other affections propagated by inoculation. There is reason to believe that it is connected in some subtle manner with a vitiated condition of the blood, and that it causes changes closely resembling those diseases in their characters; for cases frequently come under notice which illustrate and strengthen this view. There is no necessity for dwelling upon its absorption by the lungs or by the alimentary canal, since such inquiry, interesting though it be, leads to the consideration of internal diseases rather than of surgical complications. The cases here to be dealt with are those in which the mischief commences in a diseased or injured part, as an ulcer or a wound; and to such surfaces or to a mucous membrane, as that which lines the nostrils, putrid or other animal matters are frequently applied. It signifies little whence these matters are derived, whether from decomposing pus, unhealthy secretions, decomposing hides, dead bodies, vegetable putrefactions,* or from animals suffering from acrid discharges, as in glanders; since their influence, regulated by the intensity of the poison, for they vary in this respect, and by predisposing causes presently to be mentioned, may be recognised under two modifications only.

In the *first* of these the action is *general.* The poison is rapidly absorbed and diffused, either in the veins or by the lymphatics and their associated glands. The blood undergoes decomposition, or, as some please to have it, passes into a state of fermentation; but withal does not present any appreciable change. Within twenty-four hours, in *acute cases*, there are rigors, vertigo, and general uneasiness. Then follow heat, perspiration, and increased rapidity of pulse. The seat of inoculation is dusky, indurated, often pustular, or if it had been before secreting pus the discharge ceases. Radiating from this centre, the integument is distending with a serous effusion, presently to be mingled with thin sanious pus. The swelling, generally somewhat elastic, is hard and tense over enlarging and painful glands. The blood, deranging the heart's action, is circulated violently and rapidly through the system; exuding from its vessels, as in purpura, it stains the surrounding tissues, forms ecchymoses in internal organs, or is poured out upon mucous surfaces, and is then chiefly removed with purging or vomiting. In another twenty-four hours, the patient—flushed, anxious, restless, even delirious—is in a hopeless condition, with prostration and rapid sinking. In other instances the affection is *less acute* in its progress, the poison causes a less disturbance, and the symptoms are insidiously developed. They then simulate those of typhoid fever, to which disease this form of systemic infection bears a close resemblance, and may be recognised as a common cause of death after surgical operations, the patient sinking gradually without any apparent reason, but with symptoms of a low febrile character. If the blood eventually rights itself and the patient recovers, convalescence is slow, owing to the feeble condition of the system—a condition caused by direct disturbance from the poison, and by the fluxes of one kind or other which ensue, and aid, perhaps, in eliminating the virus.

In the *second modification* the action of the animal poison is *purely local*, is oftener recovered from, and, if fatal, its progress can be explained by predisposing causes, or by changes which depend upon secondary complications. Pus, it is well known, causes local irritation if applied to any excoriation, or even to a mucous surface, as the conjunctiva covering the eye—an irritation all the greater if the pus is putrid. Decomposing animal matters, as those already mentioned, and we may add decomposing serum, have the same effect, as also have many chemical irritants, such as ammonia. These facts, established by observations and by experiments, do not admit of question. If such substances are applied accidentally to any trivial abrasion, or more especially to a suppurating surface, in which also, under certain circumstances, decomposing matter may originate, the patient, if in good health, notices at the worst the formation of a pustule, or an increased purulent discharge. Organisable lymph is quickly poured out, and the neighbouring tissues are thus effectually separated from the irritating substance. If, however, under predisposing influences, this lymph breaks down and softens, or is replaced by a purulent material, diffused inflammation is at once established, and invades the tracks of cellular tissue beneath the skin, along the course of arteries, veins, or lymphatics, as the case may be. Extending rapidly, it has no limit, and the patient sinks, unless the disease is arrested by treatment. Some carbuncular inflammations and malignant pustule afford familiar illustrations of this affection, which is closely allied to the phlegmonous form of erysipelas, and of course presents every shade of intensity and of rapidity of progress up to the extreme alluded to. Its extension along the track of the blood-vessels will be again referred to in connexion with the blocking up of veins with fibrinous coagula.

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* Gaspard, *Journal de Physiologie,* tom. ii. p. 14.

In all these cases of systemic infection *predisposing causes* may be recognised in the habits and constitution of the patient, or in the conditions by which he is surrounded. They alone explain the general or the local character which, in this or that case, the disease assumes; and simple though this explanation may seem, it is the only one which can reasonably be offered. Predisposing causes then intensify the general effect, converting a comparatively trivial local mischief into the worst form of systemic infection, or by their absence render of no effect the most virulent animal poison. Various as they are, they may be grouped under certain well-known conditions. (*a*) Previous illness, either of a chronic character, or specially connected with blood-disease, from which the patient is slowly and with difficulty recovering, as pneumonia, dysentery, or scarlet fever. (*b*) Extreme prostration of the system from organic disease, as phthisis of the lungs, degeneration of the kidneys, conditions often associated with the desponding state of mind noticed in this malady, and by some accounted its cause. (*c*) Exhaustion consequent upon surgical complaints with the eventual shock of an operation, as in diseases of joints,[*] severe fractures of bone, cancer of the breast, ending in amputation. (*d*) Parturition, difficult and protracted, or overtaking women in feeble health, more especially if symptoms arise in the treatment of which depletion is employed, or if in this, or in the previous conditions, diarrhœa or vomiting should interpose. (*e*) Effect of unhealthy occupations and of exposure, as during the late war in the Crimea, of which Mounier states, that no pyæmia was noted among the first two thousand amputations, whilst afterwards it became of quite ordinary occurrence, associated with gangrene, scurvy, and typhoid fever. (*f*) Over-indulgence in food or in spirituous drinks; sudden abstinence from such indulgences; and lastly, certain conditions which would seem to be hereditary.

Such are the circumstances and habits which engender a feeble and unsound state, in which slight injuries have effect which would have none in a healthy constitution.[†]

Impure air, such as results from crowding of patients, neglect of their wounds, and of decomposing animal matters discharging from them, also enfeebles, nay prostrates, the sick man; though it by no means gives a special character to the disease, merely reducing him to a condition favourable to the development of pyæmia, erysipelas, gangrene, and other allied disorders. Except as regards movements in the air, ventilation, heat and cold, and their relative effect in the decomposition of animal matter, little stress need be laid upon atmospheric influence. Mental depression is undoubtedly associated with this disease, and its influence may materially aid the development of systemic infection, and pyæmia, when acting in concert with more directly predisposing causes.[‡]

The one important change which results from the various predisposing causes is a *modification of the blood*. Constituents are

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	per cent	
[*] Pyæmia is the cause of death in	10	of all cases of amputation.
,, ,, ,,	70	,, fatal amputations of expediency.
,, ,, ,,	43	,, ,, primary amputations.
,, ,, ,,	25	,, ,, secondary amputations.
,, ,, ,,	43	,, ,, pathological amputations.

It appears to be a more frequent cause of death in amputations through limbs the tissues of which are in a normal condition, and where a large surface of healthy bone is exposed. Bryant, *Med.-Chir. Trans.* vol. xlii. p. 88.

[†] Chevers, *Guy's Hospital Reports*, 1843, p. 90.

[‡] Solly on *Pyæmia*, in *Lancet*, vol. i. 1851, p. 289.

probably left in it, unused or unremoved, from defective secretion or embarrassed excretion, some of which are ready, on the least disturbance, to undergo decomposition. Chemistry fails to give us conclusive evidence of these changes. It is found by many, indeed, that fibrine is deficient—hypinosis—in scarlatina, in cases of exhaustion, of starvation, and in most of those which come under the denomination of cachexia, whilst by others the very contrary is asserted to be the case.* Alcohol, taken habitually in excess, diminishes the fibrine;† and in this, as in most other instances of deficiency of fibrine, the albumen and the fatty principles are relatively increased. Clots when formed within the vessels are soft and infiltrated with serum, forming a gelatinous-looking mass, a tissue of fibrine containing between its fibres a large proportion of fluid serum. They lack contractile power. Lymph, when effused, is laden with corpuscular and granular matter, and soon acquires the character of pus. The blood, when removed from the body, as by hæmorrhage, forms in about the usual time a soft coagulum, buffed and slightly cupped, in which the white corpuscles are found in great excess, as in the blood of women shortly after delivery; it seems in other respects impoverished, and its fibrine is deficient in contractility, as well as modified in actual quantity.

Materials, too, in process of absorption may have entered more or less directly into the blood, as after chronic pneumonia, or may be present in excess during some natural process. Lactic acid in the blood of women after parturition is one of these; and Mackenzie holds that it is capable of producing, when introduced into the blood artificially, the phenomena of some forms of puerperal pyæmia.‡ Whatever the morbid condition may be, the blood in these cases, as noticed by Bouillaud,§ has a tendency to coagulate in its vessels during life on the least provocation, and then to enter upon other changes.

Having seen that systemic infection is caused by some animal poison, and that, influenced by predisposing causes, it may become a general disease, more or less rapid in its progress, with symptoms allied to those of typhoid fever, or may be limited to a local action more or less diffused, the *secondary complications* have next to be considered. These may follow the general or the local disease, and are more especially referred to under the name "*pyæmia.*" Those consequent upon the general disease may be at once disposed of. First, the blood in many of these cases is so altered from its natural state that, exuding from its vessels, it diffuses its colouring matter, and the rapid progress of the disease leaves no time for further changes. Secondly, in more chronic cases, local suppurations may be established, chiefly of a pustular character; and in this there is a resemblance to smallpox or scarlatina, blood-diseases, as they are termed, in which pustules or abscesses follow the introduction of a virus, or result from extreme debility.

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* Vogel, *Pathological Anatomy of the Human Body*, English Trans. p. 69. Bouchut, *Mémoire sur la Coagulation du Sang veineux*, &c. in *Gazette Médicale de Paris*, 1845, p. 260. Becquerel and Rodier, *Pathological Chemistry*, English Trans. p. 56.

† Huss, *Alcoholismus chronicus*, Stockholm u. Leipzic, 1852. Peters *On the Pathological Effects of Alcohol*, in *New-York Journal of Medicine*, vol. iii. No. 9.

‡ Mackenzie, *Med.-Chir. Trans.* vol. xxxvi. p. 210.

§ Bouillaud, *Archives générales de Médecine*, 1823, tom. ii. p. 189. Bouchut, op. cit.

The *secondary complications* which may follow the local disease, but are often dependent upon conditions very different from any of the preceding, are marked by *symptoms* sufficiently characteristic. The patient, weak and enfeebled by previous disease, or influenced by other predispositions already described, complains suddenly of cold, and is presently attacked with rigors. In nearly all surgical instances, for example, in twenty-eight out of thirty-three of Arnott's* reported cases, the patient is described as going on well when the symptoms first become declared. If a wound is suppurating at the time, the discharge often ceases, its surface becomes dry, and the surrounding integument acquires a dusky hue. The rigors, of varying severity, are repeated at brief intervals, or, though this is the exception, twenty-four hours may elapse before they recur, no symptoms arising in the interval. Perspirations, sometimes profuse and causing considerable exhaustion, sometimes scanty, succeed the rigors. The skin soon becomes dry and harsh, but towards the close of the case, if it terminate fatally, there breaks out a cold clammy sweat. The pulse, rising rapidly to one hundred or one hundred and thirty beats in the minute, is feeble, sometimes intermitting, and though jerking, is easily compressed. The tongue, at first but little altered from its condition prior to the attack, soon grows dry on the dorsum, and is covered with a brownish fur. At the same time there is a remarkable sense of depression. The countenance is anxious and oppressed, the eyes sunken, and the expression vacant. There is often pain about the head, and the patient, restless and irritable, fails to obtain accustomed sleep.

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* *Med.-Chir. Trans.* vol. xv.

With these symptoms there exists a tawny discoloration of the integument almost characteristic of the disease, requiring, however, to be distinguished from the jaundice tinge with which it is sometimes complicated. Without the intercurrence of other symptoms, the patient may pass quickly into a typhoid state, and thus, in a few days, the disease may terminate fatally, or, less rapid in its progress, may tend to gradual sinking, the patient lingering* for several weeks.

When any one organ is especially involved, new symptoms arise. Delirium, rarely of a violent character, with pain about the head, the patient growing heavy and drowsy, answering only when roused, and then with hesitation and indistinctness, points to the nervous centres as chiefly implicated. Hurried respiration, dyspnœa, slight cough, sense of weight about the heart, or pleuritic pains, point to the thorax and its contents. Sickness and vomiting, or diarrhœa with bloody stools, containing shreds of fibrine, mucus, and pus, point to the intestinal canal, and recall the fact that this disease is sometimes associated with dysentery. Diarrhœa with copious bilious evacuations points to the liver, as also do stools consisting of crude food without any bile, especially when combined with jaundice; and this is confirmed by pain in the hepatic region.

These local symptoms dash in and point to where the stress of the disease is borne, showing how the patient will probably die, whether by coma, apnœa, or asthenia. The main symptoms, those of depression and prostration, advance the while. In the extreme exhaustion at the close of this malady, it is not unusual to observe discharges from various surfaces, as from the nostrils, from the ears, or from the uterus in the female, or to meet with effusions into serous or synovial sacs. For the patient, with a sudden complaint of pain, will often draw attention to a joint, swollen and rapidly distending, or several articulations may be found painlessly implicated in the disease. Nor is it unusual to see on the integument patches of dusky discoloration, as though local deaths were commencing before dissolution, or to notice pustular eruptions, or the rapid development of boils.

It is unnecessary to describe the muttering delirium, the parched tongue, the lips discoloured with sordes, which indicate a fatal termination. The symptoms are the same as those of low typhoid fever.

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* After operations the symptoms of pyæmia have commenced any time from the second day to the third or fourth week. After parturition they usually commence within the first ten days. The patients have sometimes lingered for two or even for three months. See also Bryant and Arnott, op. cit.

Few recoveries from the secondary complications (pyæmia) are recorded; and even in these the symptoms mark an early stage, when the existence of this disease has been suspected rather than proved. In isolated cases, patients have recovered after severe rigors, followed by some of the local symptoms, as dyspnœa. Expectoration of puriform mucus from the lungs, the passage of bloody and copious stools, observed in these recoveries, have been regarded as eliminating processes by which the system is relieved of the morbid material influencing the blood.

Many *pathological changes* are found in the dissection of fatal cases. Some of these are referable to the primary disease, others to the secondary complication. Amongst primary affections may be observed diffused suppuration, as that which accompanies the second modification of systemic infection.* Pus, or pus mingled with serum, is then seen infiltrated through the tissues, more especially the cellular, or limited to the course of the arteries, the veins, or the lymphatics. Such suppuration may have extended from a wound, as after an operation, or it may start from a fractured bone, or maybe from inflammation of internal parts, as of the pleuræ, of the lungs, and of hydatid tumours, whilst in other cases the process may have commenced about ulcers, as of the integument, or of the mucous membrane, as in dysentery. In the midst of these suppurative changes, the veins are found filled with clots, and these clots undergoing various changes. It must here suffice to state,† that, at first of a deep red tint, they become brown, or of a rust colour; the red corpuscles diffuse their contents and lose their shape; the clots then soften, and presently become diffluent, so that, after a short time, varying from a few days to a week or more, they form a yellowish fluid resembling pus, or have a sanious appearance from being mingled with colouring matter of a deeper tint. Gulliver first drew attention to these changes, and they have been since examined by Bristowe, and more fully by Virchow.‡

These conditions, it is true, can be demonstrated only in veins of considerable calibre, but it is reasonable to believe that they occur in the smallest branches, as at the base of an extending ulcer, or around a suppurating tissue; for secondary hæmorrhage is chiefly prevented by the closing of such vessels with coagula, without which they would of necessity bleed when their walls break down in the progress of the disease. The clots once formed, changes ensue (the predisposition being the same) similar to those in other veins; only, as a rule, the larger the vessel and the greater the extent of softening coagulum, the more serious and rapid are the secondary effects. And it cannot be too strongly urged that, although the tissues around veins and even the outer wall of these vessels may be the seat of diffused inflammation, ordinary pus is never found in their interior on dissection, except when an abscess bursts into their canal; and that there is no evidence that their lining membrane inflames, although it may be involved in gangrenous processes.

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* Bouillaud, op. cit. p. 192. Dumas *Sur la Présence du Pus dans les Vaisseaux de l'Utérus*, in *Journal de Physiologie*, 1830. Graves' *Clinical Lectures*, vol. ii. p. 295, 2d edit.

† For further consideration of the disease of veins referred to, see the article DISEASES OF VEINS.

‡ Gulliver, *Med.-Chir. Trans.* vol. xxii. p. 136. Virchow, *Cellular-Pathologie*, Zweite, neu durchgesehene Auflage, p. 178.

In other cases there are conditions of even more common occurrence than the preceding, which account for the formation of the clots. Small vessels, ruptured in contusions and causing ecchymoses, are often closed by coagula, conservative against hæmorrhage, but sometimes dangerous from their insidious extension, for no symptoms mark their progress,* and subsequent disintegration. Their presence is recognised in some cases of failure in the union of bones broken near the medullary foramen. They may extend from ecchymoses of the surrounding tissue into a femoral or other principal vein, and to the sinuses of the brain after injuries of the scalp. The case of a man, aged sixty-two, will illustrate this mode of formation and extension of coagula. Whilst following his ordinary employment he fell heavily on his left hip, and sustained a fracture at the neck of the femur. He sank four months after the accident from chronic bronchitis. The rectus muscle and the adductors were greatly ecchymosed, and there was a considerable ecchymosis by the side of the femoral vein as it lay upon the adductor longus. The superficial veins were unaffected, but many of the more deeply-seated were filled with coagula softening at the centre. These veins were found entirely upon the inner side of the thigh, in the vicinity of the ecchymoses. They opened directly into the femoral, which was filled by a decolorised clot, about two inches in length, terminating at the junction of the external circumflex, just below the profunda, fig. 1, *b*. This clot was soft, and disintegrated at its centre so as to resemble pus, fig. 1, *a*.* The inner coat of the vein was natural, and there was no suspicion during life of the existence of the coagulum.

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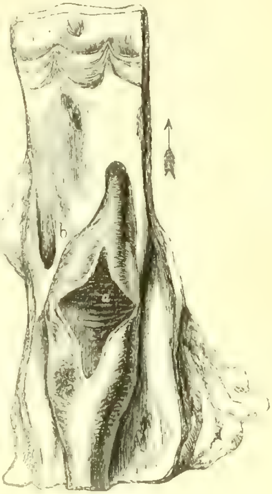
* In these and other cases it has long been known that no serous infiltration of the part follows the occlusion of even the principal venous trunks. See Bouillaud, op. cit. p. 196.

Fig. 1.



Another man, also sixty-two years of age, was brought into St. Bartholomew's Hospital suffering from symptoms of concussion, which followed a fall on the vertex, with laceration of the scalp. He quickly recovered from the immediate effects of the accident, but died on the twenty-sixth day with symptoms of pyæmia. The veins opening into the superior longitudinal sinus were distended with disintegrating coagula, and the sinus was filled from end to end in the same manner. Its walls were natural, and the adjacent membranes of the brain were free from inflammation, nor was there any fracture of the skull, but in the immediate vicinity of the smaller veins there existed several slight ecchymoses. The lungs were filled with secondary deposits.

Many such cases might be referred to, if necessary; but the above are sufficient to illustrate the fact. Similar clots, extending from the placental surface of the uterus, assist in explaining cases of puerperal phlebitis not due to diffused inflammation of the cellular tissue around the pelvic veins.

Thus far it must be clearly understood of all these cases, that clots are somehow formed in the venous trunks, and that their presence is capable of direct proof, or is a matter of reasonable inference. The probable connexion between these clot-formations and the secondary abscesses will be subsequently considered.

The post-mortem appearances which belong to the secondary complications accompany some one or more of the preceding conditions. The following table of thirty-one cases, taken in sequence from the report-books of St. Bartholomew's Hospital, shows their more frequent situations, and the relation of each with a primary affection. It has been thought desirable to include the medical with the surgical cases.

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* Museum of St. Bartholomew's Hospital, series xiii.

CASES OF PYÆMIA.

Nature of the primary affections.	Situation of the secondary complications.	No. of cases.	References to the cases in the first column.
1. Phlegmonous inflam. of scalp	Lungs	23	1, 2, 3, 4, 5, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 24, 25, 26, 27, 28, 29, 30.
2. ,, ,, mediastinum			
3. ,, ,, leg			
4. Diffused infl. of pelvis after lithotomy			
5. Pelvic cellulitis	Brain	8	1, 6, 17, 20, 23, 28, 30, 31.
6. Wound of scalp			
7. Gun-shot wound of ilium	Liver	7	4, 12, 15, 19, 22, 28, 29.
8. Compound fracture of femur			
9. ,, ,, femur	Kidneys	7	9, 13, 14, 17, 19, 29, 30.
10. Amputation of thigh	In joints 2 Around ,, 4	6	7, 16, 24, 25, 29, 30.
11. ,, thigh			
12. Empyema			
13. Empyema	Muscles	4	7, 18, 24, 30.
14. Empyema			
15. Typhoid ulceration of small intestine	Heart	4	1, 13, 29, 30.
16. Dysentery			
17. ,, with rheumatism	Spleen	2	14, 20.
18. Eroding ulcer of spleen			
19. Suppurating hydatid in omentum	Skin	2	24, 30.
20. Abscess in lungs			
21. ,, liver	Bones	2	18, 27.
22. ,, uterine wall			
23. ,, orbit	Intestine	1	30.
24. ,, neck			
25. ,, sterno-mastoid muscle	Prostate	1	1.
26. ,, axilla			
27. ,, around diseased hip-joint	Uterus	1	31.
28. ,, in thigh			
29. ,, over left radius	Trachea	1	2.
30. ,, ,, right tibia			
31. Cancer of uterus	Testis	1	17.

Although the capillaries of the lungs, coming first in the order of the circulation with reference to the primary disease, are most frequently involved, the above table, which fairly represents the results to be obtained from the cases reported by various observers, shows that the secondary changes are by no means limited to the first set of capillaries, but implicate with much irregularity various parts of the body. They present the following appearances.

When present in the *lungs*, they are found in various stages of progress; they are situated more frequently in the left than in the right viscus; they occupy the lobes indiscriminately, and lie beneath the pleural surface or deeper in the pulmonary tissue. When superficial, their serous covering is usually inflamed; and soft lymph smeared over its surface, and yellowish shreds hanging from it at once point out their situation. Sometimes the pleural sac is even filled with pus, which is usually thin and laden with lymph-masses. The deposits are easily detected by touch, hard, resisting, and isolated amidst crepitant lung-tissue. When cut across, they present, according to the progress each has made, some such conditions as the following. In those just formed there are small ecchymosed spots, caused by stasis of the blood in some of the capillaries of a lobule. This red consolidation extends until the whole lobule is involved, and then stops, probably where the artery branches off before entering it. Unless two adjacent lobules happen to be simultaneously affected, these changes are at first limited to one, and this explains their tolerably uniform size in this their commencement.* The vessels are simply filled with coagula; for the lobule, though solid, is not gorged with blood, nor does it bulge and so compress those which lie around. After a short time the parts first consolidated begin to acquire a rusty tinge, then a lighter brown, at the same time softening and presently becoming diffluent; minute yellow specks appear and extend, or sometimes the brown or sanious colour persists surrounded by the red ring of as yet unaltered coagula, and if now examined under the microscope, they are found to consist of fatty granules, amorphous débris, and altered blood-globules. These changes are quickly succeeded by others. Irritation is kindled in the parts around, which become red, congested, and this time with effusion or rapid cell-growth, so that when the lobule first affected is thoroughly disorganised, it is infiltrated with materials which reach it from the surrounding inflammation, and its contents are mingled with ordinary pus-cells. This advanced condition constitutes the abscess as usually observed, and described as a collection of pus surrounded by congested pulmonary tissue of a deep crimson colour. These abscesses now vary greatly in size, so that the same lung contains some no larger than a pea, and others which form masses of considerable extent. No satisfactory evidence can be offered to show that their progress is ever arrested, and repair or cicatrisation commenced. Their contents are never found thickened, drying up as it were, with puckering and shrivelling of the surrounding tissue. The expectoration of fibrine-like matter from the lungs, in cases of supposed recovery, has, however, induced the suggestion that such changes may in rare instances ensue.

Liver. Secondary deposits commence in this organ by the filling here and there of portal capillaries and associated veins with coloured clots, so that they are distinctly mapped out upon a cut surface of hepatic tissue. The subsequent and surrounding congestion is less intense than in the lungs, owing to the coarser character of the capillary network, but the change in colour, fig. 2, and the

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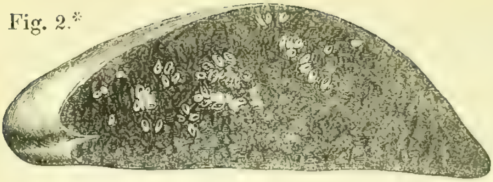
* See Lee on *Phlebitis*, p. 29.

Fig. 2.*



softening take place as rapidly. At this stage the microscope enables us to detect amorphous material, fat granules, and a sprinkling of hepatic cells, but no pus-corpuscles. There ensues an exudation into the neighbouring tissues, which are soon infiltrated with lymph and serum. This softens, and, in the unhealthy condition of the system, is quickly mingled with pus, and so an abscess is formed. But as yet before the abscess is confirmed a very characteristic appearance is presented. A number of firm nodules of a yellowish colour are conspicuous; these are the occluded vessels, representing the outer part of the lobules; around them is a pale-gray, jelly-like network enclosing them as it were, and this is the surrounding effusion of lymph and serum. Even after the softening of the fibrine and the formation of pus, the abscess retains some trace of its origin; for when the pus is washed away, a mass of tough tissue remains, in which can still be traced the skeleton of the lobules.

As surrounding parts are involved, they pass through similar changes, so that in the same liver may be seen fibrinous plugs, lobules with lymph effused around, and abscesses of varying size, in their turn bordered by exudation-materials, for no distinct wall invests them, and in their general characters forcibly recalling to mind the diffuse suppuration of subcutaneous tissue as distinguished from a simple abscess. If from any circumstance the diffusion is arrested, the diseased lobules are soon bounded by organisable lymph, and in some cases the wall thus formed becomes thick and membranous, after the fashion of that which lines a chronic abscess. At the same time the contents thicken and begin to dry up, as though a curative process was commencing; further changes are, however, usually prevented by the death of the patient, so that there remains a doubt whether these abscesses are ever completely cured, even in cases reported to have recovered after symptoms indicative of their presence.

Skin. Lee has recorded† three conditions of the integument as observable in these cases, which seem to be modifications of one another. First, a pustular eruption resembling that of smallpox; secondly, irregular spots of congestion of a dusky colour; and thirdly, congested patches darkest in their centres, rapidly passing into mortification, usually with extension of the congestion to parts around, though sometimes limited by a line of demarcation. These patches are apt to form at points subjected to pressure.

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* From a drawing in the Museum of St. Bartholomew's Hospital, No. 271, showing part of a liver with the portal capillaries and associated veins of many lobules filled with decolorised coagula.

† Op. cit. p. 53.

Changes similar to those in the lungs and liver occur in other organs with immaterial variations. Those in the *kidneys* have been studied by Beckman, who has arrived at the conclusion, now generally received, that they originate in plugging of the capillaries, and in all cases, as noticed by Lee, there is observed a want of vigour to establish adhesive inflammation. The situation of the secondary deposits is capricious, not merely as to the organ which they involve, but as to the part of each organ implicated.* The more vascular tissues are of all most prone to be affected, but it is in the least vascular that the subsequent changes are most rapid, as, from the more complete cutting-off of blood supply, gangrene most constantly ensues. Wherever secondary deposits are developed, they may in turn, if the patient's life be sufficiently prolonged, become the source of others, which pass through similar changes, and may be termed for distinction tertiary.

Other secondary changes. Effusions into serous or synovial sacs, commonly into those of joints and of the pleuræ, rarely into the ventricles of the brain, constitute another class of changes. The ordinary secretion may be increased, becoming in the case of joints less viscid than natural; or there may be an effusion of serum, lymph, or pus, or of pus stained with blood. In some cases, the cause of these changes may be traced to irritation from a collection of pus somewhere close at hand, as beneath the pleura, or in the tissues which immediately surround joints. The effusions occur without material congestion, and generally towards the close of fatal cases.

In considering the *exciting causes* of secondary complications—pyæmia—it must be remembered that the same predisposing influences as those already described,† bring the blood into a condition favourable to the development of the disease, and so reduce the patient that he is little able to resist its progress. The frequent occurrence of these secondary abscesses after surgical operations has induced many observers to inquire into their causes, and to offer explanations of their origin. From the mass of writings upon the subject, it is necessary to select the views which have received the greatest amount of credit, and to relate the arguments by which they have been supported.

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* Arnott, *Med.-Chir. Trans.* vol. xv. p. 57.

† See ante, pp. 268, 9.

(*a*) *Pus introduced into the blood.*

Of all exciting causes none has been more generally insisted upon than this, and many arguments have been brought forward in its favour. The connexion of the secondary abscesses with a primary local suppuration; the presence of pus-cells in the blood; the characters of the secondary abscesses; and the results of experiments, are its principal props. These must be severally examined.

Connexion of secondary abscesses with a primary local suppuration. When phlebitis was attracting general attention, it was observed to be frequently followed by secondary deposits. On further examination, phlebitis was found to exist in most cases of pyæmia, and nothing was more natural than to look upon the two as closely connected. Attention had been already drawn by Boerhaave, Morgagni, and Desault,* to the presence of secondary abscesses after ulcers and after suppuration, involving more especially the brain, and they had been ascribed by the latter to some nervous influence; but, although Tessier supported the doctrine of a purulent diathesis,† most writers, including Rose, Dance, and Arnott,‡ inclined to the view of their dependence upon the introduction of pus into the blood. So long, then, as phlebitis was believed to give rise to suppuration within the veins, the coexistence of these secondary affections was easily accounted for. Either from breaking down of the clot which should have limited the suppuration, or from absence of such clot owing to a degenerate condition of the blood, the pus, it was argued, directly or through some collateral branch found its way into the general circulation.

But cases coming under notice in which no phlebitis could be demonstrated, it was observed of these that they accompanied some form of suppuration, as that in wounds after operations, that of diffused inflammation of internal parts, as the mediastina, or abscesses in bone, and other structures, as for example the prostate gland.

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* See Morgagni, *De Sedibus et Causis Morborum*, lib. iv. epist. 51, art. 17, 18, 19, 20. Riber, *Recherches sur la Phlébite*, in *Revue Médicale*, tom. iii. Quesnay, *Mémoires de l'Académie Royale de Chirurgie;* Paris, 1819.

† Tessier, *Exposé et Examen critique des Doctrines de la Phlébite, &c.* Paris, 1838.

‡ Rose, *Med.-Chir. Trans.* vol. xiv. p. 251. Dance, *Archives générales de Médecine,* tom. xviii. p. 473, xix. 5, 161. Arnott, op. cit.

The idea of the absorption of entire pus-globules through the walls of veins was speedily abandoned; and although some maintained that putrid serosity alone found its way into the circulation, and so excited the diseased action, the belief gained ground that the pus passed into the open orifices of veins,—a supposition strengthened by the frequency with which, as noticed by Cruveilhier, the secondary affection followed injuries and operations upon bone, in which tissue the veins, it is well known, neither collapse after division, nor contract upon the clots which form and afterwards shrink within them. In other cases, it was urged, the opening in the vessels might result from ulceration and sloughing of their walls; and the irritation of a surrounding suppuration was supposed to reopen even those veins which had been closed in the healing of wounds.

On the other hand, it was noticed how often pus *might get into* the blood and yet no symptoms of pyæmia ensue, and how many secondary affections occur before any local suppuration has been established. It is now known that the lining membrane of veins rarely presents evidences of inflammation; that it probably never secretes pus; and that the appearance of suppuration noticed in these vessels is, in truth, caused by softening clots.* The above views are, therefore, in part untenable; and for the rest, the necessity no longer exists for making open veins take up the pus which chances to surround them.

The presence of pus-cells in the blood. Healthy pus applied to blood as it flows from a vein hastens coagulation simply as a mechanical agent. It does not mingle with that fluid, but coagula form around in from two to three minutes, and the coagulation is slowly diffused. Serous pus and the serum of decomposing pus cause more general coagulation; for, as they incline to mingle with the blood, they present a greater number of centres for coagula to surround.

And it should be observed of the experiments from which these results were obtained, that the pus was simply dropped into the blood, and not stirred up with it, whereby undue artificial mingling was avoided.†

After injection of small quantities of pus into the veins of living and healthy animals, none of it can be found in the allied venous trunks; but, traced beyond these, it is recognised as arrested in the first set of capillaries in the course of the circulation, so that its corpuscles undoubtedly circulate with the blood, though it is reasonable to infer, from their action upon that fluid out of the body, that they become capsulated with fibrine as they flow onward, and that by the same process their size is modified. Now, many observers go so far as to affirm that, in the disease in question, they can recognise pus-cells in the human blood, scattered amongst the red disks (when viewed with the aid of the microscope), the latter retaining their usual appearance, except when the pus is present in large quantities. Under such circumstances, Gendrin states that blood-corpuscles are converted into pus-globules; and mingling pus and blood in the proportion of one to eight, he proves that, after twenty-four hours, none but pus-corpuscles can be detected. But Gluge and Vogel have shown that pus, acting like water, simply dissolves the capsule of the corpuscles, and that this is the cause of the modification noticed. All, however, agree that pus-cells, when present in small quantity, do not interfere with the red disks, from which they are easily distinguished. It is from their resemblance to the white corpuscles that their detection is rendered difficult and doubtful. Granting they have entered the circulation, can then the pus-globule be distinguished from the white blood-corpuscle? Sédillot,* who has carefully considered this question, is confident in the distinction to be drawn between the two. "The pus-globule," he says, "is $\frac{1}{100}$ to $\frac{1}{80}$ of a millimetre in diameter, whilst the white globule is $\frac{1}{120}$ to $\frac{1}{100}$, a sixth or a fifth smaller. The pus-globule is slightly yellowish, the other is a dead white. The pus-globule is spherical, the white one flattened, being at most lenticular, but never spherical; its surface is smooth and indistinct, whilst that of the pus-globule is roughened or granular. The nuclei, when shown by means of acetic acid, are found larger, $\frac{1}{300}$ to $\frac{1}{200}$ of a millimetre in diameter in pus-cells, and exhibit in their interior a regular, well-defined cavity; while white corpuscles contain nuclei much smaller ($\frac{1}{500}$ to $\frac{1}{400}$), resembling nucleoli, or rather fatty granules. The white," he adds, "when present are less numerous than the others." How far these differences are available for diagnosis, those can well judge who are in the habit of examining such cells under the microscope. If present, the pus-globules may disorganise the blood in some subtle manner, causing its fibrine to separate and coagulate here and there in the capillaries, or they may determine secondary abscesses by their mechanical arrest and by the changes which then ensue.

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* See article on Diseases of Veins.

† See Mackenzie, op. cit. p. 196; Lee, op. cit. p. 26.

Dance and other observers,† however, are unable to detect these pus-globules, or altogether deny their presence in the blood. Gulliver* draws attention to their extreme variability in size, showing in animals with circular blood-cells that, however small these might be, there would certainly be some globules of pus equally small, whilst others of greater magnitude might possibly be formed by the aggregation of the more minute granules. Some explain their absence by suggesting that they are mechanically compressed, and so no longer recognised, just as they entirely lose their character when mingled in small quantity with blood out of the body, and entangled in contracting fibrine. The experience of many observers shows, in opposition to the opinion of Sédillot, that the white globules are greatly in excess in all these cases, even in those in which no source of pus-cells has existed; that their number is naturally very variable; that it increases rapidly after certain processes, as digestion; and that they are abundant during pregnancy, and for some time after delivery. Whilst, then, uncertain of our ability to distinguish between the two, the differences being trivial and difficult to detect, even as described by those most favourable to their recognition, the fact of our having under many, perhaps under all circumstances favouring pyæmia, an excess of white corpuscles, prevents the evidence in favour of the presence of pus-globules in the blood from being accepted as conclusive.

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* *De l'Infection purulente*, p. 262, note by Lebert; Paris, 1849.

† Donné, *Cours de Micrographie*, p. 82; Paris, 1844.

Character of the secondary abscesses. These having been examined when completed, to the exclusion of the preliminary changes, and being found laden with pus, were naturally adduced in favour of the theory of their purulent origin. It is now certain that no pus-cells are found in them at their commencement.

Results of experiments. It has been proved at various times, by the injection of pus into the veins of living animals, that veins inflame; that veins do not inflame; that local coagulation immediately results, or, as Majendie states, that coagulability of the blood is destroyed; that the injection is followed by fibrinous deposits; that it is followed by purulent deposits; that pus-globules, when mingled with their serum, cause most rapidly the secondary affections; and, on the contrary, that pus-corpuscles, when separated from their serum, produce them most constantly:† but these different results are intelligible enough if the difficulties which beset experiments of this nature, and the extent to which observers are always biassed by the doctrines of the day, are duly considered. Repetition of the most important leaves no doubt that the more recent experiments, especially those by Sédillot and Lee, have been accurately observed, though great allowances must be made in drawing deductions to be applied from them to the human subject, if only on account of the healthy condition of most animals operated upon, and the slowness with which they take up diseased actions, especially of a suppurative character. The results obtained may be briefly shown in a series of typical cases.

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* *Med.-Chir. Trans.* vol. xxiii. p. 21.

† Reumert, *De Symtomatibus Inflammationis Venæ Cavæ Diss. inaug.*, Havn. 1840; Gendrin, *Histoire anatomique des Inflam.* vol. ii. pp. 13, 14; Mackenzie, op. cit.; Gaspard, op. cit.; Lee, op. cit.; Sédillot, op. cit.

(1) After single injections of pus, animals, if previously healthy, usually recover; so that four to twenty grammes were often injected by Sédillot without causing inconvenience; but that this is not invariably the result, is shown by the following experiment.* One half-drachm of recent pus, injected into the right femoral vein of a dog, caused immediate death. The femoral and allied veins as far as the right auricle, that cavity, the commencement of the vena cava superior, and the right ventricle were filled with a continuous dark-coloured coagulum, in various parts of which portions of the pus were sequestered. The blood was fluid in the veins of the opposite side, in those of the head, and in the left cavities of the heart.

(2) Simple inoculation with pus of the tissue surrounding a vein is followed by slight local suppuration, the blood remaining unaffected in the adjacent vessel; and no change results from the application of pus to the edges of wounds in venous trunks, although in these experiments some pus-globules probably pass into the circulation. The wounded veins are repaired in the usual manner.

(3) Injections of small quantities of pus are usually followed by secondary deposits. About eight drops of pus were injected into the right femoral vein of a small dog. The animal, on recovering from the chloroform, refused food, and after twenty-four hours began to snuffle. It was killed, by division of the spinal chord, at the forty-eighth hour. The vein was natural from the ligature upwards. The lungs were irregularly studded with spots of a red colour, averaging a line or two in diameter. These consisted of minute vessels gorged with blood, probably coagulated, for it could not be removed by pressure. Their uniform appearance depended upon their limitation to single lobules.† Examined

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* The experiments here narrated, originally described by various authors, have been repeated to corroborate their accuracy, and those thus repeated are here cited, as they agree in the main with the originals.

† Museum of St. Bartholomew's Hospital, series xiii.

under the microscope, they were found to consist of ordinary constituents of blood mingled with granular cells.

(4) If the animal is in a healthy condition, the secondary appearances pass off. At the same time as the last experiment was performed, about twenty drops of the same pus were introduced into the right femoral vein of another dog, and the animal was killed at the ninety-eighth hour. The veins were healthy throughout. In the left lung only one, in the right two small ecchymoses still existed, similar to, only rather darker than, those noticed in the preceding experiment. The other organs were natural.

These examples are taken from amongst many, and are easy of repetition: they serve to illustrate the fact that pus is arrested in the first set of capillaries, and that the blood-stasis which ensues presently rights itself and eventually clears off.

(5) The secondary abscesses are obtained by Sédillot* and others by injections repeated at intervals, in animals consequently enfeebled by disease. Similar results may be obtained in dogs which are let blood before introduction of the pus, three or four days being allowed to elapse before the abscesses are looked for.

(6) Similar or allied results follow the injection of many other substances; thus, decomposing serum mingled with pus-débris causes even more diffused effects than pus, and acting more after the manner of the poisons alluded to as causing systemic infection, gives rise to local gangrenous lesions, with considerable extravasation of blood into the surrounding tissues. Experiments have been recorded by Cruveilhier and Gaspard showing some of the substances besides pus which are arrested in the capillaries; thus the latter writes: "les corps trop grossiers, tels que le mercure, l'huile, le sédiment de l'extrait d'opium, &c. ne peuvent pas outrepasser les petits vaisseaux intermédiaires aux artères et aux veines;" and both describe the formation of the secondary abscesses. Gaspard's† experiments also prove that similar substances, carried rapidly through arteries, produce violent local irritation in those parts only to which the branches of the injected artery are distributed.

(7) It happens sometimes that pus, and it is only of pus the fact has been recorded, slips by one set of capillaries, as in a case narrated by Sédillot,‡ in which, the mesenteric veins being injected, the liver remained unaltered, whilst the lungs became the

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* Sédillot, op. cit. p. 128.

† Gaspard, op. cit. tom. v. p. 319; Lee, op. cit. p. 38.

‡ Sédillot, op. cit., dix-huitième expérience, p. 101.

seat of secondary abscesses. This cannot be ascribed to any difference in the size of the two sets of capillaries; but it has led to the suggestion that pus-globules are only arrested in their course when they become aggregated, or increased in bulk by the addition of materials from the blood.

Thus, although the secondary complications seem to follow upon the introduction of various substances* into the blood, of which pus is one, and perhaps depend upon their mechanical arrest in vessels intermediate between the arteries and veins, yet, on applying the results of these experiments to the human subject, they are met by the facts that pus-globules are not of a certainty found in the blood; that the secondary abscesses are often unconnected with any primary local suppuration; and that they are not in the first instance purulent. With the exception of decomposing serum and other fluids of an allied character, which can only excite the complications by setting up some vital or chemical action, those who support the mechanical origin have but one material other than pus by which to explain the secondary changes; but this is so generally present in cases of pyæmia, that it requires separate consideration. Embolism is the term by some applied to the consequences which may ensue from the extension of clots in veins, their displacement, the separation of fragments from their surface, or their softening and disintegration; and the simplicity of the changes, the reasonableness of their occurrence, and their accordance with the symptoms and post-mortem appearances of pyæmia, appeal strongly in their favour as explanatory of the disease.

Before entering upon their consideration, however, a few words may dispose of the theory of a purulent diathesis, which, indeed, proposed in times long past,† refers to what is now regarded as the unsound condition induced by predisposing causes, in which the system is prone to suffer from suppurative or typhoid diseases. In the same way may be dismissed such theories as presuppose, that fibrine about to be eliminated into pus undergoes a retrograde metamorphosis, is carried on in the circulation, and causes like actions to go on in the accompanying fluid; also the older, but less farfetched idea, of the influence of a nervous action; a view entertained in consequence of observations by Desault on secondary affections connected with injuries to the skull and its contents. With these may be classed absorption by the lymphatics, which of late years has been, by most observers, discarded as a cause of the secondary complications. The cases which are quoted in its favour are found, on inquiry, of a doubtful character; some are incorrectly reported, as can easily be seen, now that more is known of the subject; for example, Dumas narrates several in which the lymphatics about the uterus (mistaken doubtless for the veins) were filled with pus, which, however, could not be detected in the associated glands, where it was consequently supposed to be in some way elaborated.* Other cases have been examples of diffused inflammation in the course of the lymphatics, or have been connected with changes independent of the absorbent system.†

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* Amongst these fibrine should be enumerated. See Sédillot, op. cit., onzième expérience, p. 86, also p. 110.

† De Haen, *Ratio Medendi*, tom. i. p. 102 et seq., Paris, 1761; also Tessier, op. cit.

An ingenious idea, applicable more especially to cases in which pyæmia follows surgical operations, as after excision of a testis, or amputation of an extremity, has been originated by the suggestion that materials, harmless to those organs and textures to which they should have been applied, when unused or unremoved from the blood, act as local irritants to other structures, and so engender secondary mischief, such as effusion of puriform fluid into joints. These materials may have affinity with chemical substances, but they do not admit of recognition by physical means.‡ Chevers lays great stress upon previous abdominal complications, observing, "It is highly probable that, in most of the individuals who thus perish, even if they had never become the subjects of any wound or injury, some other vicissitude would, by bringing the renal or hepatic mischief into active operation, have equally determined the occurrence of fatal cerebral, thoracic, or abdominal inflammation."§

Whether materials be thus provided in the changed or diseased condition of the blood, or whether they are derived from a source external to the body, may be held in dispute so far as the primary infection is concerned; but, apart from predisposing causes, to consider the secondary complications, as some have, to depend upon such deranged conditions of blood, and an accompanying tendency to stasis and spontaneous deposit of fibrine in the capillaries, seems scarcely borne out by experimental or other inquiries, which, on the contrary, favour the probability of their mechanical origin.

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[*] Dumas, op. cit. p. 106.

[†] Lee, op. cit., case xxix.

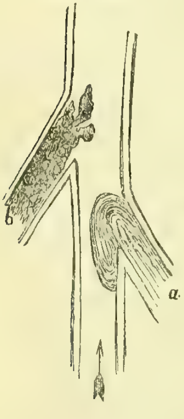
[‡] Finger, *Präger Vierteljahrschrift*, no. iv. 1847.

[§] See Simpson, *Med. Times and Gazette*, vol. i. 1859; Chevers, op. cit. p. 94.

(b) *Disorganised fibrine introduced into the blood.*

As is more fully detailed in describing diseases of veins,* *coagula are formed in these vessels*, with inflammatory changes of adjacent tissues and of the outer wall of a vein itself, in the vicinity of suppurating tissues, or in veins ruptured by violence. When a predisposition exists, very little is sufficient to cause their deposit. Bouillaud† writes of them as often noticed in the cachectic from simple pressure, in the veins of the pelvis from compression by cancer of the ovaries, and in the internal iliac from distension of the sigmoid flexure with hardened fæces; and, as bearing upon their connexion with pyæmia, Tweedie mentions a case in which this disease followed a contusion of the thigh, Lee, one after a blow upon the patella. These coagula, when formed in a small vein, are limited in either direction by the first collateral current, though they may extend past one or more of these into larger vessels, involving at last important canals, if aided by predisposing circumstances, and by a blood-condition thereon dependent. Disregarding the influence of any surrounding inflammation, and looking at them as hindered in their extension by the resistance of the blood as it sweeps past them, they may at first encroach upon and in time pass these currents by the addition to their surface of irregular plates of fibrine, as shown in the accompanying woodcut (fig. 3, *a*); an encroachment which may be prevented if the greater force and capacity of the collateral stream be sufficient, even under adverse predisposing circumstances, to keep clear its channel. Once arrested in their progress, particles may be loosened and carried off from their surface, where washed by the flowing blood, and then pass on through the veins (fig. 3, *b*), entering pulmonary arteries of a smaller and lessening diameter, until they at length lodge, usually at a bifurcation, where, as after the application of a ligature, new clots form upon them. These detached portions undergo various changes, and, if cutting off any considerable supply of blood, may cause even gangrene of the part involved. They are of interest, in connexion with *clot-*

Fig. 3.



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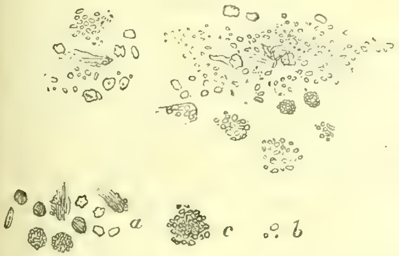
* See article on Diseases of Veins.

† Bouillaud, op. cit.; Bouchut, op. cit. p. 244; Lee, op. cit. case vi. Humphry *On the Coagulation of the Blood in the Venous System during Life;* Cambridge, Macmillan and Co.

softening and *disintegration*, as showing how smaller particles, when circulating with the blood, produce even more noticeable effects.

Whatever may be the cause of this softening, the fact is undoubted, and has been carefully studied in connexion with the clots, or polypi, as they were formerly termed, which are found under certain circumstances in the cavities of the heart. It is associated with an unhealthy condition of fibrine, whereby it is wanting in contractility, and retains in its meshes an undue quantity of serum. The disintegration commences in the oldest portion of each coagulum, so that it may affect one side, one extremity, or the middle of a clot, as the case may be; it is accompanied by the changes in colour already described, and, from their often acquiring the appearance of ordinary pus, the earlier observers were led to consider these clots as true purulent collections. When examined under the microscope, they are found to contain (fig. 4, *a*) blood-cells variously modified; some mere shreds, others serrated and puckered; some, probably white corpuscles, being pale and transparent when acted on by acetic acid. These are entangled amidst a quantity of granular matter and globules, composed, perhaps entirely, of oil soluble in æther (fig. 4, *b*); here and there many of these granules and globules form masses of very variable size, irregular in their outline, though sometimes having a surrounding cell-wall (fig. 4, *c*), which, however, can seldom be demonstrated. These, also, are soluble in æther. Lastly may be noticed irregular masses of varying size, portions, perhaps, of fibrine as yet unreduced to a granular condition.

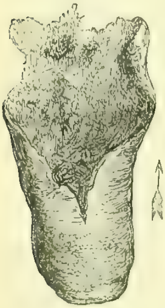
Fig. 4.



Such is the material, as recent observations show, which is prepared in cases of pyæmia to enter the current of the circulation, and to excite the secondary complications by mechanical obstruction of the capillaries, setting up local irritation and impeding function, and so causing actions of an ordinary inflammatory character to become established. Virchow, Beckman, and others, support this explanation.

Three questions naturally arise from the preceding statements, and require a brief notice. (*a*) Do disintegrating clots acquire the characters of true pus? There is no proof that they do. They sometimes contain simple cells which have been regarded as inflammatory products; but pus-cells are not detected, so at least say these observers. Their statement, however, must be received as offered under the existing views of pus-formation, of which much might be said for which the present is scarcely the place, though attention may be drawn to the revival in some sort of the doctrine, descended from Hunter, and so much insisted upon by Gendrin, that pus-cells are *not* changed blood-corpuscles, but cells re-formed from the disintegrated blood-constituents. (*b*) How does the softened clot-débris find its way into the circulation? First, through some collateral branch connected with the vein where closed by the softening mass; secondly, by rupture of the clot-wall which separates the débris from the circulating blood (fig. 5), either at its distal extremity, opening into the nearest branch, the clots entangled about the valves preventing their perfect closure, or at its proximal end, the further formation of a clot to confine the débris being usually prevented by the presence of a strong anastomosing blood-current. (*c*) Are these softening clots found in all cases of secondary complication? Sometimes their presence is easy of proof, sometimes it may be inferred from the existence of a morbid change with which they are usually associated. Their presence is certainly more constant than that of any other condition with which pyæmia can reasonably be connected when considered, as here, apart from septic infection, that is, as in itself a distinct affection. In the latter, it may be concluded that animal products undoubtedly modify the blood, causing mischief of a typhoid or pyogenic character; in true *pyæmia*, that a material, some say pus, others the débris of softened clots or detached portions of fibrine, finds its way into the blood, and gives rise to *mechanical obstruction*, in which secondary abscesses have their origin; and both of these (septic infection and pyæmia) are modified or determined by predisposing causes.

Fig. 5.*



Effusions of pus into serous and synovial cavities are easy of explanation so far as pyæmia is concerned. Many of them depend upon contiguous irritation, as previously mentioned; and the actual effusions are less frequent than has been supposed, cases of suppuration around being sometimes taken for those of pus within the cavity of a joint. But there are cases in which these effusions occur during the later stages of the disease, and, like the pustular affections of the cuticle, indicate extreme modification of the blood. Such cases must be considered apart; they are merely coincident with the pyæmia, and their explanation must be sought for in common with that of like changes which, first noticed by Petit, and now familiar to all physicians, occur in the course of scarlatina and allied diseases.*

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* Museum of St. Bartholomew's Hospital, series xiii. Clot from a pulmonary artery, its softened contents discharged through its distal extremity.

Opinion must vary as to the *prospect of recovery* from systemic infection; and so much depends upon the previous habits and condition of each patient, that without a knowledge of them it is easy to be wrongly biassed. Thus in cases of septic poisoning, as has been already stated, one person recovers from an inoculation of a violent character, whilst another succumbs to one comparatively trivial. But though we may be doubtful of the result and cautious in opinion at the commencement of the disease, all uncertainty is soon removed as the symptoms incline to convalescence, or acquire the familiar characters of rapid or of protracted sinking. The slowness with which the symptoms are from the first developed may be regarded as, on the whole, a favourable sign; whilst, if there has been great constitutional disturbance before the turning-point is reached, a slow convalescence must be anticipated; or, if the disease has been associated with profuse and exhausting suppuration, surfaces may be left to heal, or diffused abscesses to contract and close, under the burden of which patients sometimes sink.

What is to be said of the prospect of recovery from the secondary complications? Taking those cases in which no doubt has existed of the nature of the disease, is it probable that a fatal result invariably ensues? It is true that some cases are recorded in which patients have recovered, but in few of these is the existence of pyæmia clear or certain.† It is probable that a fatal result must generally be anticipated; for, setting aside all that may be argued on the one side or on the other, practical surgeons acknowledge that very little chance remains for the patient who, after an operation, is attacked with the symptoms of this disease. This is no matter for surprise when the predisposing conditions are taken into account; indeed, pyæmia is dependent upon a state with which life can scarcely be prolonged; so that if the secondary abscesses did not interpose and hasten the end, death would none the less result from the exhaustion consequent upon the original mischief. This view of the prognosis, which facts justify our taking, urges most strongly the necessity of attending to prophylactic measures.

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* See an interesting case reported in the *Med.-Chir. Trans.* vol. xxi. p. 148.

† See especially cases recorded by Sédillot, op. cit. p. 325 et seq.; also a case narrated by Dr. Watson in the *Principles and Practice of Physic*, 3d edition, vol. ii. p. 324.

The *diagnosis* of these disorders presents no difficulty, and though septic poisoning in many cases has symptoms analogous to typhoid fever, the history of each case will suffice to distinguish between the two. If, indeed, no distinction could be drawn, it would be of little moment, as the two diseases require much the same treatment, and only differ materially in their secondary complications, which are easily recognised, and are at once characteristic of the malady to which they belong. By inquiring, then, into the history of each case its nature is always evident, nor is it likely to be confused, even when accompanied by pain in the articulations, with diseases so well marked as those of a rheumatic nature. Secondary complications, as they first declare themselves after operations with rigors, and constitutional disturbance, have symptoms in common with many surgical fevers; but their typhoid character is soon declared, and the rapidity of their progress, or the intercurrence of local physical signs, presently remove all doubt as to their nature.

In the *treatment* of systemic infection both local and general measures are required.

Local remedies. An excoriation, an ulcer, or a suppurating wound may exist, as has been seen, for the reception of the poison; and, although no satisfactory explanation can be offered of the fact, it must be assumed that wounds may themselves engender septic matter. For a short time after the inoculation all local action is at a stand-still, then follow fœtid local discharges or gangrenous sloughing, and it is before these changes indicate the extension of the mischief, and whilst it seems to be limited to a given spot, that local means may be most advantageously employed. When a part is poisoned by the bite of a venomous animal, the poison can be removed, or its influence weakened, by the simple operation of sucking the wound, before, as is supposed, it has had time to enter into the system by absorption; and were the act of inoculation capable of such easy recognition, some remedy might, after the same fashion, at once arrest its action. Unfortunately in the majority of cases the first notice of this disease comes from the symptoms of a more or less serious character which ensue. Take the earliest of these, such as pain about an excoriation, with slight duskiness of the surrounding integument; can any measures be recommended to destroy the suspected spot before the septic material has extended its influence to the tissues beyond? A similar question has been raised in the treatment of syphilitic sores, and has been answered in the affirmative; and so, in the cases before us, nitrate of silver may be freely applied, and even stronger remedies, such as nitric acid, if a greater destruction of tissue is thought desirable, the part so treated being afterwards enveloped in soothing fomentations or emollient poultices. Excision of the part supposed to have been inoculated can scarcely be recommended, not because of the inefficiency of the operation when soon enough performed, but because in such cases escharotics would answer equally well, and for the same reason amputation of small parts, as the fingers, is seldom necessary. The prospect of destroying the poison by local measures applied to suppurating wounds is far less than when abrasions or recent wounds have to be dealt with, and therefore all the greater care should be taken of their general management. Should they become infected, their treatment must be as simple as possible, all sources of irritation, as foreign bodies or accumulations of pus, should be removed, and fomentations or water-dressing should be applied. The part should be kept clean by frequent bathing with tepid water, and its position should be arranged so that all lodgements of pus may be prevented. It is possible also that charcoal-poultices, or chlorine preparations, may be advantageously employed; but acid and other lotions, supposed by some to act by neutralising septic animal products, have proved of very doubtful utility. Should diffused inflammations supervene, they must be treated after the fashion of phlegmonous erysipelas, and, as their very existence depends upon the feebleness of the patient, it must be remembered that antiphlogistic measures are inadmissible. If the infection has become general, local treatment must be limited to the dressing of the wounds, if any exist, with some simple applications.

General remedies. It is always as well to inquire into the habits of each patient before adopting any general treatment, as individual cases require that principles which hold good for all should be variously modified for their special benefit. There can be no question as to the necessity of prompt attention, even before general symptoms are developed, to the various secretory functions. Nausea, if present, should be allayed according to its cause, and the alimentary canal should be cleansed by a dose of calomel and jalap, or by a milder aperient; and this may be done on the mere suspicion of a systemic infection. As soon as the disease becomes declared, the first object in its treatment is to promote, if possible, its elimination, at the same time allaying nervous irritation and supporting the patient's strength.

If the *elimination of the poisons* could be effected, the symptoms would undoubtedly subside; but so little is known of their action, and their nature is so obscure, that it is difficult to suggest remedies for their removal. It would seem as though the system might be relieved by the increased action of the secretory organs, and this view is apparently favoured by the congestions which accompany the disease, and by the fluxes which often ensue. The fluxes are, however, often met with when the blood is so greatly altered that it readily parts with its serum, or, together with its colouring matter, is exuded from its vessels, these having probably undergone some previous change in the structure of their walls, which itself determines the flux. It is reasonable notwithstanding to give eliminating remedies a fair trial, so as to encourage secretion from various organs; but they must be tried with caution, lest they add to the prostration which so invariably accompanies the disease. Medicines may be given to promote secretion from the intestinal canal, and saline draughts may be ordered, with the addition of bicarbonate and bitartrate of potash, to increase the renal excretion. The patient should be kept warm, and the action of the skin should be encouraged by diaphoretics; warm water, and even vapour baths, as recommended by Macartney, may prove useful in some instances. With such treatment the cases of reported recovery have been conducted to their favourable issue: it has appeared to aid the effort of nature to right the condition of the blood, and might probably be usefully combined with other remedies which should act more directly upon that fluid through the organs of respiration.*

The nervous depression also constitutes an important feature of systemic infection, and is not infrequently combined with irritability and restlessness. Nothing soothes these conditions so well as opium, which, in one form or other, should be given in small and frequently repeated doses, unless in isolated cases there exist some particular objection to its use. When the patient is kept well under its influence in the manner recommended, it seems to act more efficaciously than when given at irregular times, or at long intervals, or even frequently in the very large doses recommended by some surgeons. Dover's powder is another remedy which may often be usefully employed as a night-dose in addition to the opium. Should *sickness* or *vomiting* supervene, the stomach should be left as quiet as possible, medicine and necessary food being given in the smallest possible quantities, repeated as frequently as occasion requires. This vomiting is often a very troublesome complication; perfect rest is its best treatment, though sometimes it seems to be allayed by doses of chloroform or of dilute hydrocyanic acid, or by the taking of small quantities of ice. *Diarrhœa* seldom calls for interference, as, from the previous remarks, it will be recognised as one of the means by which the system seeks relief, and should rather be encouraged within certain limits, by the administration of mild aperients. If accompanied by exudation of the disorganised blood, it does not admit of arrest by treatment; but if simply profuse, it may sometimes require checking, lest the patient be too much reduced by its persistence.

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* Experience shows that no reliance can be placed upon medicines, such as the chlorides, which are supposed to act by neutralising the morbid condition of the blood.

Disturbance of the circulation requires no particular attention, as it is quite a secondary affection, and can only be relieved by elimination of the poison which excites it. Nevertheless, if a patient suffers inconvenience from tumultuous action of the heart, and consequent dyspnœa, the over-worked organ should be relieved if possible. Such relief may be found in the fluxes already mentioned, and especially in free excretion from the kidneys, regulated, of course, in its production by the state of the urine. Digitalis is also useful by its more direct action upon the heart, and better still, according to the interesting statements of Simpson,* a strong tincture of aconite, or preparations of the veratrum nigrum (very similar to those of the veratrum album), may be recommended.

Last, but not least in importance, is *the necessity of supporting* the patient's strength during the progress of the disease. Measures to this end are, in most cases, required from the first onset of the symptoms; indeed it is probable that the patient, if previously under treatment, will be already upon some plan of supporting or tonic remedies. The quantity to be given, and the stimulants to be recommended, vary of necessity in individual cases, and depend so much upon general principles of treatment, that it is needless to consider them more fully; and the same may be said of the precise period at which this treatment ought to commence. There is no use, however, in wasting time before the stimulants are poured in; if they are to do any thing, they should be trusted and tried at an early stage, before positive failure of the strength commences. Brandy and sherry are the best; they should be given in small quantities, frequently repeated, and with them should be ordered such light but nutritious food as the stomach ought to bear without being excited to nausea or vomiting. Given with other remedies at an early stage, save in exceptional cases, the action of the stimulants should be carefully watched for in the *general* symptoms of the patient, and thereby regulated; for the pulse, owing to the condition of circulation kept up by the poison, is a bad criterion of their efficacy.

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* Op. cit. p. 516; also Tessier, op. cit.

If the patient recovers, care will be required during convalescence, for the system is slow in answering to the stimulus of ordinary tonics. Change of scene, dry bracing air, and strengthening medicines, naturally suggest themselves; such remedies as bark, and more especially the various preparations of iron. There is no security against a relapse, and none against a recurrence after a longer interval of a similar or an allied infection, except in the careful after-management of these cases.

In the *treatment* of the *secondary complications* (pyæmia), the *general remedies* are much the same as for the systemic infection; the depression is, however, usually greater, and calls for an earlier and more free administration of stimulants; mercury, depletion, and the like remedies, being altogether inadmissible. The *local measures*, so far as any recognised primary mischief is concerned, have been already mentioned. No local treatment can prevent the formation of secondary abscesses; not even the pressure upon the veins above the local mischief, suggested by Hunter, to bar the entrance of foreign or other matters into the system, by causing obliteration of the canal, nor yet the amputation of the part first diseased, as some surgeons would have us to believe.* Even for the relief of the local abscesses, opium is the only remedy on which reliance can be placed, and of course its action is simply palliative. Effusions into joints should be treated by soothing lotions and rest: they are rarely so painful as to call for interference; under any circumstances, all that can be done is to lay the articular cavity open, to allow the escape of pus, and to prevent re-accumulation by placing the part in a position favourable to the escape of fluids.

The little that can be done in the way of treatment when these diseases, more especially the secondary complications (pyæmia), are fairly declared, leads to the question of their prevention; and as this necessarily implies that the cases are brought early under notice, it can only apply to a limited number, and chiefly to those which follow operations. It must suffice to glance at the predisposing conditions which can be usefully dealt with.—*Previous disease.* The essence of preventive treatment lies in the improvement of the general health. The broken-down subjects of disease and starvation are prone to all the troubles which may follow a surgical operation; they require careful preparation before undergoing so serious an affair. They must be strengthened by tonics, such as quinine or iron, and their secretions must be set right by appropriate alteratives: this treatment, too, must be continued for a considerable period; for if the health be much broken, it is slow of taking effect, and its employment for only a few days prior to an operation is of course simply useless. The diet should at the same time be attended to, and persons of intemperate habits should be accustomed to a more healthy mode of living, although in no case should the stimulants be too suddenly withdrawn. Simple as these details appear, the success of an operation often depends upon their observance: in many cases, no doubt, they are unattainable; in some from social circumstances, in others from the rapid progress of a disease which forbids delay; if so, and the operation is indispensable, it has to be performed under unfavourable circumstances. In all cases, the condition of the internal organs must be looked to; the urine should be tested for albumen, and the state of the thorax and of the abdomen should be noted; should any of them be found ailing, knowledge of the fact may enable something to be done to better the patient's prospect.—*Previous restraint.* Under all circumstances the system, if possible, should be accustomed to the new conditions in which it will be placed; and by preparatory rest in bed, the patient should get over the irritation which such confinement often induces. To this Chevers refers,[*] when he draws attention to cases in which, although the patients had been taking daily exercise in the open air up to the time of undergoing operations, and subsequently lay in wards which were apparently very free from noxious exhalations, they nevertheless sank in a very few days from pneumonia and other thoracic affections of the most aggravated kind. If this holds good for the inhabitants of crowded dwellings, it does so the more for those accustomed to active country occupations, who are suddenly shut up in the comparatively close and ill-ventilated air of hospitals and sick-rooms.—The *general treatment after operations*, in cases predisposed to these disorders, consists in supporting the strength and in giving a nutritious diet; and on the least suspicion of failing power, this plan of treatment must be pushed still further. Opium is also of great service when given in doses sufficient to keep the system quiet and free from irritation; and under the continuance of this influence, reparative processes appear to progress most favourably. Wounds should be kept perfectly at rest, care being taken to promote their early closure; for when this is attained, exhausting suppuration is avoided and the disposition to pyæmia is lessened; they should also be kept clean, and free from irritation. To this end they should be cleansed with tepid water applied with new lint; whilst sponges and soiled dressings should be carefully avoided, lest they inoculate the wound with discharges from other sores. Not only is this a probable occurrence, but there is ground for believing that surgeons carry the poison from one case to another, so that some caution should be exercised in the examination of wounds, and in the re-employment of instruments, lest the disorder spread amongst patients crowded together, as in the wards of a hospital, and in whom it is easily excited owing to the predisposition induced by the confined air and other circumstances already referred to.—*Chloroform* has probably a depressing influence upon the system, in some cases more so than in others; but without here discussing the subject, it may be asserted that the cases are few, if any, in which the occurrence of these diseases can be attributed to the effects of its administration. By doing away to a great extent with the shock of an operation, chloroform, it is true, lessens the reaction; but there is no reason for regarding this as an unfavourable influence.

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* See Sédillot, op. cit.

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[*] Op. cit. p. 85.

GEORGE WILLIAM CALLENDER.

TETANUS.

THIS disease is generally described as *a powerful and painful spasm of the voluntary muscles, which is long-continued and uncontrollable.* The spasm of the muscles is that of rigid contraction, and from its constancy and non-intermitting character it has been termed *tonic.* These spasms continue without any interval of complete and perfect relaxation, except in the last stage of the disease previous to death; and although violently increased from time to time by sudden and most severe paroxysms, yet they are never for an instant discontinued altogether, so long as the complaint can fairly be said to exist. The spasms are not to be mistaken for those of convulsions, which consist in alternate spasms and relaxations, remitting and intermitting, and often receive the appellation of *clonic.*

Tetanus has been regarded as consisting of several forms and varieties, based upon some peculiarity in its mode of development and subsequent course. In former years it used to be subdivided into classes, according to the predominant affection of certain muscles, and thus varieties have been described—Trismus, Opisthotonos, Emprosthotonos, &c.; afterwards it was considered more advisable to arrange it according to the probable cause, into *traumatic*, where it arises from injury, &c., and *idiopathic*, where no external or visible cause is apparent. Again, tetanus has been classed according to its intensity, rapidity, and duration, under the denominations of *acute*, *subacute*, and *chronic* tetanus. For practical purposes we may regard the disease in two forms, recollecting at the same time that both are one and the same affection, modified in intensity and in its effects by some peculiar condition: 1st, the *acute form*, which is generally met with after injuries, but may also exist, though more rarely, in the idiopathic variety, and is for the most part fatal: 2d, the *chronic form*, the usual type of idiopathic tetanus, yet occurring in the traumatic variety; this is the form which raises the hopes of the surgeon and physician, as recovery may take place by judicious treatment.

We shall, however, confine ourselves to one description of the disease, viz. the acute form, and reserve for separate consideration such modifications and deviations from the typical affection as offer any special peculiarities.

Premonitory symptoms. Although there can be no doubt that, in many instances, there may be certain signs which usher in this complaint, yet these do not differ from the ordinary premonitory symptoms of other diseases, and do not lead us to anticipate its onset: thus we may find an uneasy sensation in the wound, or an additional pain thereof, or the wound may become inflamed and irritable; there may be febrile symptoms and restlessness, languor and debility, loss of appetite, headache, constipation, &c.; still not one of these symptoms is in any way peculiarly and especially associated with the approach of this terrible disease.

The first evidence of tetanus unfortunately and but too truly portrays the unmistakeable nature of the disease; the condition of the muscles of the jaw, or the aspect of the patient, at once announces the victim.

Mr. Morgan* has given a very graphic, although in parts somewhat exaggerated, description of the onset, progress, and termination of this disease in its acute form; and as it is generally quoted, we have thought it better to transcribe the account given by him, instead of adding another description to the already overstocked number. He writes: "The first *decided* symptoms will almost invariably be an uneasy sensation and stiffness in the muscles of the lower jaw and tongue, which does not, however, in the *first* instance, amount to actual pain, unless the parts are a good deal moved about, and generally about the same time *stiffness is observed in the back of the neck.* Thus the first complaint of your patient will often be, 'that he has taken a cold, and is suffering from a *sore throat* and *stiff neck;*' and therefore, unless the friends and attendants are made acquainted with the importance of keeping a strict watch for the occurrence of these symptoms, and the necessity for an immediate application of remedies, they will be attributed to a wrong cause; and thus the disease will be gradually gaining ground till the only hope of safety is gone, for the sole chance of recovery from the use of remedies depends upon their early application. Some have complained of a violent pain under the sternum as a concomitant symptom.

"As the disease proceeds in its course, the patient complains of *difficulty and pain in masticating and swallowing his food;* the lower jaw soon becomes completely fixed and closed, and with every effort to open the mouth, the pain, which is now continued and severe, is increased to agony. In this early stage you will usually find that the muscles connecting the head and neck with the body are affected, and that the concomitant symptoms are languor, debility, and either complete or incomplete bending of the body backwards.

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* *A Lecture on Tetanus,* 1833.

" The next symptoms will be a convulsive cramp in all the affected muscles, brought on by any attempt to swallow; and the very idea of being obliged to make such an effort excites an expression of horror and distress in the countenance. Sometimes in the early, and more rarely in the advanced, stage of tetanus, the stomach will be sympathetically affected, and, in consequence of this, nausea and vomiting will occasionally occur.

" The next constant symptom will be a *sudden, violent, and continued pain*, increased at short intervals by spasm extending from the scrobiculus cordis to the spine, in the situation of the diaphragm.

" Shortly after this symptom has shown itself, the *abdominal muscles* will be constricted and hardened by tetanic cramp; and the contraction of these parts is so permanent and violent, that, on pressing upon the abdomen, the muscular fibres convey to the hand the sensation of a hard board beneath the skin, rather than that of living animal matter.

" In the course of time all the voluntary muscles partake more or less in the disease. The head is thrown back and fixed by the powerful contraction of the extensor muscles of the neck. The extremities likewise become fixed and rigid. The shoulders are drawn forward by the pectoral and deltoid muscles; and the arms are either stretched out or fixed in a parallel line with the trunk, or drawn across the abdomen. The lower extremities are almost invariably in a straight position, and consequently in a line with the body. But notwithstanding the continued and powerful contraction of muscular fibre in the limbs, it will be found that the wrists and fingers are but little affected; the ankles and toes, however, suffer occasionally from the effects of the disease.

" At this period of the complaint the *countenance* is pale, anxious, and contracted, and is disfigured by the perverted action of the muscles, producing what is termed ' the tetanic grin.' The spasms now become more violent and more frequent, and during their continuance and immediately after them the respiration is hurried and laborious; but in exceptional cases it may be easy and performed by the abdominal muscles. While the spasmodic paroxysm lasts *the pulse* is generally quick, small, fluttering, and irregular; but during the intervals both the pulse and respiration are comparatively tranquil.

" In some cases the spasm becomes so violent that the assistance of an attendant is necessary, during the paroxysm of cramp, to prevent the patient from being projected out of his bed. In other cases, again, the spasms are less sudden, though equally strong and painful, and consequently, instead of that jerking contraction of the muscles, the body is more gradually raised from the bed, and if the muscles at the back of the neck and trunk and those of the lower extremities are the parts most powerfully affected, then it often happens that the body at intervals is drawn into the form of a bow, and in the recumbent position the occiput and heels rest solely on the bed, whilst the lower limbs and trunk curve upwards to form a complete arch.

"It will frequently happen that, in consequence of the continued contraction of the sphincter muscles of the bladder, retention of urine takes place, and priapism will occasionally occur as a concomitant symptom.

"The *bowels* are in most cases obstinately constipated, and the large intestines loaded with offensive scybalous matter.

"The *secretion of urine* varies, but it is rarely very profuse.

"Towards the termination of the disease, the torture of the last attack of spasm, and the apprehension of the near approach of another paroxysm produce an expression of dreadful mental distress and anguish in the countenance. The sufferings are only to be soothed by perfect rest and quietude; the slightest attempt at motion immediately brings on a new attack of spasm; the opening of a door, or the waving of the bed-curtains, will throw the patient into convulsions; and even the sound of that voice which, on other occasions, might have soothed and smoothed the path of anguish and of sorrow to the grave, will now only add increased agony to intense suffering. Every sound, every moving object in the room is fuel added to the fire which is consuming the life of the tortured victim.

"At the close of life the whole face becomes distorted and disfigured, and the larynx forcibly drawn upwards; the spasm in the muscles, depressing the lower jaw, now and then alternates for a moment in severity with that by which their antagonists are affected, and thus for a moment an aperture is left between the jaws through which the tongue is instantly pushed and as instantly crushed and lacerated by the sudden closure of the teeth upon it. If a large portion of the organ should be thus wounded and strangulated, hæmorrhage will immediately follow, and the countenance and even the bed-clothes will be bathed in blood, thus giving additional horror to a scene in which the extremes of mental agony and intense bodily suffering appeared indeed to have done almost their utmost beforehand.

"In some cases the last moments will be comparatively tranquil, for exhaustion and delirium occasionally render the patient alike insensible to pain and to all that mental distress which was previously excited by apprehension and despair; but, in the majority of instances, the torture of a paroxysm of spasm terminates at once the sufferings and the life of a tetanic patient.

"The intellectual faculties remain unimpaired even to the last, and the senses are perfect, but sometimes rendered morbidly acute."

Febrile excitement is not essential, but if present is secondary. Dr. O'Beirne states that he witnessed about 200 cases; but he never saw one accompanied by fever.

Sleep rarely occurs in acute traumatic tetanus, and then only during a few minutes, or in the intervals between the exacerbations, or when the continued contractions in these intervals are not attended by much pain. In the subacute cases, however, sleep is more frequent, and a more complete relaxation of the muscular contractions takes place; but upon being wakened the full tension of the muscles returns.

The following varieties have been noticed in the characters of the muscular spasms:

1. *Trismus*, or clenching of the teeth from spasm of the muscles of mastication. This is so constant an occurrence in tetanus that the disease has received the special appellation of *locked-jaw.* We must recollect, however, that this is not the sole symptom of the disease, but only one local sign, and may be met with in other affections; this will again be referred to when alluding to the diagnosis of the disease. Towards the decline of tetanus, and where it is attended with extreme exhaustion and prostration, the spasm of these muscles gives way, and the jaw becomes relaxed and drops open.

2. *Opisthotonos*, when the body is bent backwards. This is the most common variety, and is generally noticed in the ordinary descriptions.

3. *Emprosthotonos* is when the body is bent forwards. This is very rare, and has been seldom witnessed. Aretæus has mentioned it, and Larrey has recorded several cases. The muscles on the anterior part of the body are said to be so contracted as to bend the head upon the chest, to curve the spine anteriorly, and to draw the thighs towards the belly. In very severe cases, the head is brought into contact with the knees, so that the body presents the

shape of a ball rather than that of a bow, according to the remark of Aretæus.

4. *Pleurosthotonos* indicates that the body is bent laterally. This is also very rare. It has been observed in acute cases, but more frequently in the chronic forms. In the case of a female, aged twenty-four, at Guy's Hospital, it was observed to attack the right side more especially ; it was fatal in this instance.

Trismus nascentium, tetanus infantum. New-born infants are subject to tetanus, and offer the same symptoms as are observed in adults. It usually makes its appearance about seven or nine days after birth, but may occur up to the fourteenth day. The progress is, however, more rapid in some, death taking place in ten or thirty hours : the disease is then called acute. In others, life may be prolonged to eight or nine days, and it is then termed subacute. It has been attributed to division of the umbilical cord, and hence considered traumatic ; and it has been traced to exposure to currents of air, bad ventilation, and unwholesome nutriment, and hence denominated idiopathic. It is frequent among the Negro races, and has been stated to be the chief cause of depopulation of the Negro infants in the West India isles. At one period, the infants born in the Dublin Lying-in Hospital died of tetanus within the first fortnight at a rate of 17 per cent ; but when a better ventilation became established, the mortality was reduced to 5 per cent.

There are still some other varieties in the symptoms which require to be considered ; but these must be regarded as exceptions to the general rule.

Spasms primarily attacking the muscles of the part injured instead of the muscles of the jaw. Mr. Morgan relates two cases : A sailor, a patient of Guy's Hospital, received a lacerated wound of the fleshy part of the thumb, occasioned by a splinter of teak-wood, which had transfixed the part. This was forcibly extracted at the time, and the wound healed perfectly. The first symptom of the disease occurred about two months after the accident, and consisted of a painful neuralgic affection of the muscles of the ball of the thumb, without any appearance of inflammation in the part. He died, and on dissection two pieces of splintered teak were found imbedded in the abductor muscle, and resting upon a branch of the radial nerve.—A scholar received a blow of a schoolmaster's cane on the hand. In this instance both pain and spasm commenced in the injured part, and the first true symptom of tetanus was a gradual spasmodic contraction of the flexor muscles of the hand, by which the fingers were drawn into the palm. The cramp subsequently extended to the arm and other parts, and eventually terminated fatally.

Absence of pain. Sir G. Blane mentions a curious case in which the spasmodic affections were unattended by pain even to the last moment of existence. In this instance, the cramps were accompanied by a tingling and agreeable sensation. The accesses were attended by feelings of pleasure, and a strong tendency to laughter.

Special affection of the muscles of the face and eye. Of seventy-two cases of tetanus occurring in Guy's Hospital, three are mentioned to have been so attacked, and in two of these it involved the orbicularis palpebrarum, inducing closure of the lids, and simulating ptosis. *The muscles of the eye* are sometimes but not generally affected; when this occurs, the eyeball is fixed and drawn slightly inwards, the patient being unable to direct it towards particular objects. The pupil of the eye varies, being sometimes contracted, and at other times dilated.

Cerebral complications are very rare in tetanus, but may be met with in isolated instances; thus there occurred six cases out of seventy-two admitted into Guy's Hospital: in three cases there was delirium, in two of which it came on towards the close of the disease; but, in the third case, was present before the attack supervened, and entirely subsided directly the tetanus made its appearance: in one there was *coma;* but this was considered to be owing to the large doses of morphia administered.

Epilepsy may form a complication; thus at Guy's a female, the subject of epilepsy, was attacked with tetanus a few days previous to its expected occurrence; there was screaming and convulsions, and these partook of the character of the periodic epileptic seizures.

Convulsions and screaming were observed in a young female who died of acute tetanus on the sixth day of the attack, following an incision into an inflamed bursa over the knee.

Loss of power over the extremities occurred in two of the Guy's Hospital cases.

Miscellaneous complications. Tetanus has attacked those labouring under bronchitis and laryngitis, and a fatal issue has resulted; and it has also been complicated with erysipelas, and with fatal effects. In the case of a man aged sixty-two, the skin of the abdomen was found to be peculiarly shrivelled. In one case the symptoms continued severe until the ninth day, and on the eleventh day a miliary eruption appeared over the whole body, accompanied with succession of spasms and intervals of repose. On the sixteenth day exhaustion and rambling supervened; but on the twenty-second day subsidence of the symptoms took place, and a protracted recovery ensued.

Remission of the symptoms. This is extremely rare, yet it has been noticed in several instances. Of sixty cases observed in Guy's Hospital, four had this peculiarity: in two of these there was evident relief of the symptoms for thirteen days, although death ultimately ensued from exhaustion; in the other two remission only took place for a very short period, viz. a few days, and was succeeded by more intense and fatal results. Dupuytren mentions a case in which the disease subsided for twenty-eight days, and then returned after an exposure to cold. M. Duval mentions some curious cases in which the disease assumed the form of anomalous ague, in one of which it was remarked that both sides of the body were never affected by the paroxysm, but regularly alternated in successive fits.

Death may take place in several ways:

During a paroxysm of spasm and convulsions of the muscles of the heart, larynx, &c. It is not correct, as some affirm, that death in tetanus is due to the extension of spasm to the heart. Mr. Howship thought so, and records a case in point where the heart was found firmly contracted eleven hours after death. In only one out of sixteen cases, observed at Guy's Hospital, was this condition found. In some instances sudden death has occurred whilst being raised in bed; in another during the administration of an enema; in another whilst drinking; and again, in another, immediately after the extraction of a tooth for the purpose of feeding; it has also been observed during efforts at stool.

During an attack of asphyxia and suffocation. This occurs generally from the foregoing circumstance, viz. spasm of the muscles of respiration. Thus, of forty-six cases in Guy's Hospital, in which the mode of death was noticed, in thirty-two it arose from the two foregoing conditions.

From exhaustion. This is less frequently observed, although it was noticed in twelve of the forty-six cases at Guy's.

From accidental circumstances, such as erysipelas, coma from over-dose of morphia, &c.

The causes of tetanus may be arranged under two heads: 1st, the probably immediate and *exciting* causes; and 2dly, the remote or *predisposing* causes.

I. The exciting causes comprise:

A. *Wounds and injuries. Traumatic tetanus.* There is scarcely a single lesion which may be said to be exempt from its attack, from the simple blow or contusion to the most severe compound fracture and laceration. It would be a waste of space to enumerate every form of lesion in which it has been found to occur; we shall, however, classify them in the following order: 1. Contusions and strains without wound, such as blows by a cane across the nape of the neck or on the palm of the hand, &c.; 2. Wounds of the soft parts, embracing simple abrasion of surface, incised, punctured, lacerated, and gunshot wounds; 3. Burns and frostbite; 4. Fractures and dislocations, simple and compound; 5. Minor operations, such as extraction of teeth, cupping, seton, ligature of piles, the accidental inclusion of a nerve in a ligature, incision into an inflamed bursa; 6. Major surgical operations, as amputation, castration, excision of the mamma; 7. Surgical diseases, such as gangrene, ulcers of the leg, fistula in ano, presence of guinea-worm under the integument, caries of the tibia; 8. Incidents in obstetric practice, such as abortion, retained placenta, &c.

The degree of the local injury bears no relation to the severity of the symptoms; thus, a slight contusion may be followed by the most acute tetanus; and, on the other hand, a patient with severe compound fracture may be seized with a mild attack and recover.

The following relative proportions, which the occurrence of tetanus bears to the several surgical lesions, are taken from cases of admission observed at Guy's Hospital during a period of seven years. There were of

Major and minor operations .	1364	cases:	tetanus	occurred in	1
Wounds of all varieties	594	,,	,,	,,	9
Injuries and contusions	856	,,	,,	,,	1
Burns and scalds	456	,,	,,	,,	3
Compound fractures	398	,,	,,	,,	9
	3668				23

Among the large number of total admissions of surgical disease, independent of direct accident, during the above period, only one case was attacked with tetanus; thus showing beyond doubt that its occurrence is rare in the several forms of surgical disease, and that it is most frequently met with in the more severe varieties of injury and accident, such as compound fractures, burns, and injuries to the fingers and toes.

The situation of the injury has been specially noticed as a source of frequency by some authors. Others, again, declare that the locality of the wound must be considered as almost a matter of indifference. Hennen observed it oftener after wounds of the elbow and knee; others, again, more frequently from injuries of the thumb and great toe. The extremities, however, are much more exposed and liable to injury; hence perhaps the frequency of tetanus from injuries in such situations.

As to the state of the wound at the time when tetanus sets in: some observers, amongst whom is Larrey, attribute the tetanus to a sudden suppression of the discharge of a suppurating surface, the wound presenting a dry surface, or covered over only with thin serous exudation. Others, again, are of opinion, that cicatrisation is mostly complete on the accession of tetanus; thus, Travers goes so far as to offer an explanation of this circumstance in the following terms: "In flesh-wounds the period of commencing cicatrisation, after the mundifying process is completed, seems to be the most liable to the attack of spasms. It is difficult to disconnect the phenomena of the incipient spasm with the altered condition of the nervous and muscular structure in the healing or newly cicatrised part. Cicatrisation is adhesion and the fastening of parts before free and movable on each other, and its effects would be equivalent to their strangulation or confinement by pressure of any kind, the interruption to their function being the same."

Others maintain that it occurs most frequently in recent wounds; thus John Hunter expresses his opinion: "tetanus arises also from slight wounds before either inflammation or suppuration comes on; they are generally the most frequent. It is from irritation." But he further on remarks: "When I have seen it from considerable wounds, it was after the inflammatory stage, and when good suppuration was come on."

Tetanus, however, is found to set in at any period and in any state of the wound, and there are no grounds for assuming that any one condition is more favourable to the production of tetanus than another.

The interval between the receipt of the injury and the first symptoms of tetanus is termed by some the period of accession or incubation. This varies from a few hours to many days, and must of itself depend, in a great measure, upon a variety of concomitant circumstances, which will be more appropriately considered under the predisposing causes, such as age, constitution, climate, sex, &c.

It is asserted and generally maintained to be correct, that tetanus, occurring over twenty-two days after the injury has been inflicted, is more likely to be recovered from; and that the more sudden the onset after receipt of the injury, the more fatal will be the result;

but, at the same time, we must bear in mind that some of the severest and most rapid cases have occurred where an interval of ten days has elapsed.

Of 277 cases, there were

Previous to the 10th day . . .	130 cases,	of whom	101 died.
From the 10th to the 22d day . .	126 „	„	65 „
Above 22 days	21 „	„	8 „

B. *Tetanus arising from causes unconnected with any injury or lesion of surface*, commonly known as *idiopathic tetanus*. This forms the second variety of the exciting causes, and includes exposure to damp and cold, humidity, irritation of worms, terror, sudden suppression of natural discharges and acute diseases, &c.

Exposure to damp and cold, however, seems to be the main cause of this idiopathic variety; but there cannot be the least doubt that in a great many of the traumatic cases this cause has played an essential part in inducing the disease, and although the majority of such cases are enumerated as traumatic, yet they should constitute an intermediate variety. Among the vicissitudes of temperature as a cause, the following are worthy of note: plunging into a warm bath whilst heated; falling into a river in a state of perspiration and during the flow of catamenia; sudden change from the heated atmosphere of a ball-room to the external air; in hot countries exposure to the chilly night-air and dew; also exposure to the cold and moist breezes from the sea; sleeping in the open air all night in a fit of intoxication; sleeping on the ground after fatiguing marches under a broiling sun; sleeping in confined and ill-ventilated apartments; breathing a contaminated or miasmatous atmosphere. Hennen lays less stress on the agency of cold than on that of air in motion, for all the cases that fell under his own observation had been exposed to a stream of air either hot or cold.

Irritation of worms. Worms have undoubtedly been discovered in persons dying of tetanus; thus a case is recorded among those occurring at Guy's Hospital. Dr. O'Beirne, in the Dublin Hospital reports, seems to regard their presence as of considerable effect in the production of the disease; but long before him Laurent of Strasburg went so far as to assert, that even in wounded subjects the real cause was the presence of worms in some part of the alimentary canal. It is probably a very remote and exceptional cause of the disease.

Foreign bodies in the intestines. Heurteloup relates a case in which the attack was apparently brought on by an accumulation of cherry-stones in the intestines.

Terror. Dr. Hennen is an authority as to its being the immediate antecedent of the disease.

Intense anxiety of mind is quoted by Willan as a cause.

Sudden suppression of the secretions and excretions has been mentioned. Fournier Pascay relates the case of a woman, who, while labouring under a gastric fever and in a state of perspiration, exposed herself at an open casement to the north wind, causing sudden suppression of the perspiration.

The suppression of the lochia and the suppression of acute diseases, such as variola, typhus, and gastric inflammation, have also been enumerated.

II. The predisposing causes, although remote, must necessarily be taken into consideration.

Age. Tetanus occurs at every period of life.

The peculiar affection in young infants termed *trismus nascentium* has been already alluded to. It is principally seen in the tropics, but has been occasionally met with in Europe. It occurs within the first two weeks after birth, and is supposed to depend upon irritation of the primæ viæ by meconium, worms, unnatural secretion, &c., or on a morbid condition of the umbilical fossa. This has been mentioned before, and will not come under the present consideration.

Of regular tetanus, the youngest case on record is twenty-two months, and the oldest seventy-five years of age. Of 399 cases, there were

Under 10 years of age	29 cases	
Between 10 and 30 years of age .	261 „	upwards of 60 per cent.
„ 30 and 50 „ „ .	122 „	
Over 50 years of age	37 „	

Sex. The ancients considered females to be more frequently affected, but less severely, than males. This does not accord with the experience derived from the returns at Guy's Hospital: for out of 72 cases of this disease, 12 occurred in females, being 16·66 per cent, and all were fatal; 60 attacked males, bearing an average of 5 of the latter to one of the former.

Taking a more extensive general average, deduced from 449 collected cases, it appears that males are more frequently attacked in a ratio of about 7½ to 1 female.

Constitution, habits, previous health, &c. Is there any peculiarity in the *state of the constitution?* Hunter seemed to think so; he says: "But every thing relative to locked-jaw does not arise from irritation of the wound itself, neither from inflammation nor symptomatic fever; for in such states the constitution is not disposed to it. It arises from an irritable habit, which may be increased or produced by irritation, but not such as is capable of producing inflammation. There must be a disposition for the disease; thus, madness is produced from the slightest causes when the mind is predisposed; so it is in agues and fevers, the constitution being particularly predisposed at the time to such diseases."

Sufficient attention has not been paid to this subject to insure any satisfactory conclusion; it appears that the very quiet and cheerful, the very irritable and excitable, the strumous and fair, are alike equally liable, and in each is the disease alike equally fatal.

Condition of body. Tetanus likewise attacks the healthy as well as the unhealthy, the emaciated as well as the robust and well-developed, the spare as well as the muscular. This does not correspond with John Hunter's remarks, viz. "that those most susceptible to the disease are of sickly and weak frames, and of suspicious minds, and not of strong and robust ones."

Habits of life. There is much difficulty in arriving at any definite conclusion concerning this point; it has, however, attacked the temperate as well as the intemperate, and the dissipated as well as those who have lived low. Of sixteen cases recorded at Guy's, seven were temperate, and seven intemperate and dissipated, and both bore an equal ratio, as in both there were two recoveries and five deaths. These returns are, however, too meagre for any general conclusion.

Hygienic causes. Dr. Dickson* remarks: "I trust I am, therefore, justified in inferring that to the improvements in the medical and surgical treatment of wounds, in *cleanliness* and *ventilation*, avoiding at the same time *exposure to currents of cold air*, or sudden changes of temperature; in fine, to *superior diet* and *accommodation*, but particularly to the greater attention paid to the state of the bowels, may be attributed the great infrequency of tetanus of late in the West Indies, when compared with former wars."

Races and climate. Europeans are said to be peculiarly exempt from the disease, whether in their own country or in India. There is much greater liability of the Negro race to every form of tetanus or trismus than of the white race. Mr. Peat, in his essay on tetanus in the East Indies, gives the following percentage of its occurrence among the various castes, viz.: Hindoos 1·63 per cent, Mussulmans 1·09 per cent, Parsees 1·005 per cent, and Christians 0·75 per cent. Natives of warm climates are greatly susceptible. "Is this," Mr. Travers observes, "owing to their being of a more relaxed fibre and greater susceptibility of impression both external and internal; or, in other words, that less resistance is opposed to morbid action, and that in them the disease runs its course with greater vehemence and rapidity than those of temperate regions?" John Hunter remarks, "that climate seems the first of the predisposing causes, and that which can probably produce it without any other causes. In warm climates it is most frequent. The cramp is most frequent in warm climates, and also in bed; fits also are more frequent in bed, for warmth seems to have a peculiar effect in producing a particular disposition in the nerves; and when there is an immediate slight cause, such diseases readily take place; nay, some are disposed to such action without any immediate cause, which probably arises from climate, joined with a very strong natural predisposition."

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* *Med.-Chir. Trans.* vol. vii. p. 465.

Influence of season in the production of tetanus. Respecting the separate months of the year in which it occurs, little can be gathered: it seems to be as frequent in one month as another; so also in respect to the seasons of the year, for it is found to be developed in the cold, temperate, and warm months in an equal ratio. The same results are observed in the cases occurring in the East Indies. The influence of the seasons has no effect on the mortality in tetanus. (For an extensive investigation of this point, see Guy's Hospital reports.*)

Occurrence of tetanus after naval and military engagements. Space will not allow us to enter into this question, as it will be duly considered under military surgery.

Diagnosis. There occurs sometimes a peculiar affection about the neighbourhood of the muscles of the lower jaw, which is attended with spasms and causes contraction of those muscles, resembling very much that of locked-jaw. We must not, however, mistake these purely local diseases, inducing trismus, for the actual disease itself; in all the spurious forms the contraction of the muscular fibre, although constant, is never increased by painful and distressing paroxysms of spasm; and generally, if the exciting cause be removed at an early period, the complaint will disappear. This is often observed in diseases of the alveoli from carious teeth, in ulceration of the gums and mucous membrane of the mouth, &c.; also in children during the period of dentition.

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* Ser. iii. vol. iii.

Tetanus may be mistaken for hydrophobia, in consequence of the spasms in tetanus now and then affecting the muscles of deglutition, inducing a fear of swallowing from its exciting spasmodic action, and giving rise to a dread of fluids. We will offer the leading symptoms of the two diseases in contrast with each other in the following somewhat artificial table:

Tetanus.	Hydrophobia.
Spasm of muscles more continued; less remitting, and never intermitting. Constant rigidity of the muscles of the jaw, becoming gradually fixed and closed; *tonic* spasm.	Spasm of muscles of brief duration; if not voluntary, at least temporary, and will cease to exist during intervals of rest and quietude, the jaw being relaxed, and opening and shutting readily. The spasms are *clonic*.
The cause is exposure to cold or wound, rarely from the bite of an animal, and it generally occurs soon after the injury.	Cause, the bite of a rabid animal, and it rarely appears before the thirtieth day.
The bite of a tetanic animal does not produce tetanus.	The bite of hydrophobic animals must have communicated the disease when it exists.
Countenance, tetanic; drawing up of the nose; wrinkling of the forehead; angles of the mouth drawn towards the cheek-bone, presenting a frightful risus sardonicus. There is an expression of pain, but the eyes are natural.	Countenance, hydrophobic; an expression of excitement, fearful distress, and peculiar restlessness, never to be forgotten; occasionally frightfully convulsed; eyes bright and glistening, but at times suffused.
No great thirst, and in general no great aversion to fluids administered in small quantities; rarely any discharge of saliva.	Thirst and aversion to fluids characteristic; even the sight or noise of fluids induces paroxysms; with frequent and viscid discharges of saliva; efforts to disengage it inducing barking and vomiting.
Vomiting and gastric pains rare.	Vomiting and gastric pains general.
Mind generally clear to the last.	Mind subject to rabid impulses and numberless deviations, passing to delirium.
Recovery in idiopathic forms.	No authentic case of recovery.
	Intolerant sensibility of surface and organs of sense.

Idiopathic tetanus has been mistaken for rheumatism, and treated accordingly. Both affections have as their exciting cause exposure to cold and moisture upon the body of a person previously heated, perspiring, and fatigued; and although the symptoms in both, at first, are those of stiffness of the muscles of the back of the neck and other parts of the body, yet they differ in that the one consists of a chronic and slow affection of the muscular, tendinous, and ligamentous structures, while the other confines itself to a spasmodic affection of the muscular system, influenced probably through the medium of the nervous system. However, in two of the Guy's cases, previous to admission the tetanic symptoms were treated for, and supposed to be, rheumatism.

In a temperate climate, a sudden accession of tetanic symptoms of great severity and running their course rapidly, in a person who has received no local injury, nor been exposed to cold and damp, would create a strong suspicion of poisoning. Thus there are some vegetable poisons which produce almost every symptom of tetanus, as observed either in animals inoculated therewith, or in persons who have unfortunately swallowed the poisons. *Chetik*, a poison prepared from the juice of a large twining shrub, a species of strychnos, produces artificial tetanus.

Strychnia, however, is the poison we are most familiarly acquainted with, as bearing the closest analogy in its symptoms and effects with those of tetanus. The symptoms produced in animals are general uneasiness, convulsions of a tetanic kind, muscular rigidity, arching back of the head and neck, violent stretching of the legs, and spasms brought on by the slightest touch like a galvanic shock. The symptoms, as it affects man, are agitation, trembling, tetanic convulsions, spine and neck bowed, arms stretched out, hands clenched; the stiffness when once set in never entirely disappearing; recurrence of first paroxysms and reappearance of jerking rigidity; retraction of muscles of mouth and face; the countenance suffused and red, and the pupils dilated. The patient can open the mouth and swallow; there is no locked-jaw, but spasm of respiratory muscles; terror of suffocation; laryngismus early, sudden, and intense; consciousness retained to the last; senses unnaturally acute; calmness. The time of acting is, in small doses, half an hour to an hour; in large doses, about ten minutes. In large doses, death ensues in a quarter of an hour; in small doses, from half an hour to an hour.

In the celebrated trial of Palmer for poisoning a man named Cook by means of strychnia, it was argued by the defence that the deceased Cook died of tetanus from natural causes, and not from any poisoning by strychnia, and hence arose a question as to the diagnosis of the symptoms of tetanus from those of strychnia.

The following are the facts of Cook's case: he was comparatively well up to a certain night, when about eleven o'clock he took some pills, and in three hours he was seized with great agony, and shrieked dreadfully, calling out "murder." He had rigid and cold extremities; the eyes starting, and the whole body convulsed: he was gasping for breath, but was perfectly conscious. There was a gradual subsidence of these symptoms, and he fell into a state of repose and sleep, the attack having lasted three hours. On the following day he was comfortable and conversed rationally, and was improving, having got up and sat in his chair and laughed and joked. At eleven o'clock that night he again took pills, and in an hour afterwards he complained of stiffness of the muscles of the neck; the head and neck became unnaturally bent back, and he screamed and became dreadfully convulsed, crying out, "Raise me up; I shall be suffocated." The convulsions lasted five to ten minutes, and affected the whole body, so that it was bowed back. It was impossible to raise him on account of the extreme rigidity. He was quite sensible; the action of the heart gradually weakened and ceased gradually. This second attack lasted not more than fifteen minutes from its commencement to the termination in death.

It was argued that the disease was not tetanus, for in the latter affection the symptoms commence in a mild form and then become stronger; it is gradual, continuous, and always progressive, and there is never a total subsidence of symptoms. Again, tetanus rarely runs its course in less than two or three days, oftener longer; and it never lasts for a few minutes and then subsides, to come on again in twenty-four hours. In tetanus from poisoning there are remissions or intervals of relaxation. How far these arguments hold good may be judged of by the perusal of the foregoing details of the varieties in the symptoms of tetanus.

Hysteria, combined with spasm, called hysterical tetanus, occurs in females. There is no instance of a fatal termination of this affection. The representation is often so faithful, that many instances of reputed examples of successful treatment of tetanus have been merely conquest over hysterical spasms.

Dr. Copland remarks: "In females trismus or subacute tetanus may assume an hysterical character, or hysterical symptoms may be associated with the tetanic, the disease being really tetanus and occasioned by an injury. Of this association I had a very remarkable instance many years ago in a cook in my own family. In hysteria, the spasms and convulsions are seldom accompanied with unconsciousness, or if they be so attended, the loss of sensation is incomplete and supervenes gradually; again, the spasmodic or muscular contractions are subordinate phenomena, and of comparatively short duration."

Epileptic convulsions are attended always with entire loss of consciousness; and hence are distinct from the convulsions of tetanus. This symptom often precedes the spasmodic attack; the muscles of respiration are early affected, and cerebral congestion and imperfect oxygenation of the blood result.

Apoplexy never produces tetanic convulsions. However, Dr. Copland remarks one form, "convulsive apoplexy," where the membranes have become involved, giving rise to tetanic rigidity of the muscles, more particularly those of the neck or limbs, with various convulsive movements.

Morphia sometimes produces convulsions; but these are of an epileptic character, and long in their development.

The advantage to be gained by dividing tetanus into acute or traumatic, and chronic or idiopathic, has been much dwelt upon as assisting in guiding us in our prognosis; this may be illustrated from the following quotations: Dr. O'Beirne witnessed 200 cases of traumatic tetanus in the Peninsula, not one of which recovered. Hennen confesses that he never saw a case of "acute symptomatic tetanus" recover. Dr. Dickson found all curative measures followed by unqualified disappointment. Mr. Morgan says, "I have never seen or heard of an instance of recovery from acute tetanus."

A writer in the *Edinburgh Journal*, vol. xv., says, "that the idiopathic disease is a far milder and more tractable affection, and this is a fact well known to every planter in the West Indies, who never considers his Negroes as safe when the disease supervenes on a wound, but is frequently successful in alleviating the idiopathic species."

Some author observes, that if within forty-eight hours the disease runs a rapid course, it will be fatal; but if it be not fully developed until the ninth or tenth day, there may be a favourable termination.

Parry attempted to found a prognosis upon the state of the pulse; he says: "If in an adult the pulse, by the fourth or fifth day, does not reach 100 or perhaps 110 beats in a minute, I believe the patient almost always recovers; if, on the other hand, the pulse on the first day is 120 or more in a minute, few instances will, I apprehend, be found in which he will not die."

Larrey formed an opinion, that perspirations in certain parts, as the chest and abdomen, were critical, while those beginning on the head and extremities were symptomatic only.

Recorded cases are not to be taken as evidence, inasmuch as often only successful cases are mentioned, and deaths passed by as a matter of course.

In acute traumatic cases the prognosis is most unfavourable, and there is scarcely a well-authenticated instance of recovery on record.

In subacute cases of the traumatic variety recovery does sometimes take place, and especially when there is a long interval between the injury and its accession, and where the symptoms set in mild and pursue a slow course, gradually advancing in extent and severity.

In the idiopathic variety, where it does not assume an acute and rapid form, the prognosis is for the most part favourable, and we may always hope for a chance of recovery.

Taking all forms together, in a fair average number of cases the proportion seems to be $7\frac{1}{2}$ deaths to 1 recovery.

The duration of the disease will be gathered from the following record of 327 cases:

Within 2 days . .	79 cases fatal.	From 10 to 22 days .	43 cases fatal.
From 2 to 5 days .	104 ,, ,,	Above 22 days . .	11 ,, ,,
,, 5 to 10 ,, .	90 ,, ,,		

Thus the mortality up to the fifth day is equal to, or even higher than, all the remaining cases included. The most rapid has been in from four to five hours, and the longest duration on record is thirty-nine days.

This return will considerably modify the statement generally made, viz. that if tetanus continue over a period of twenty-two days, a favourable issue is to be expected, and recovery almost certain.

The post-mortem appearances are vague and unsatisfactory in the extreme, and it is difficult to decide whether the actual condition observed is virtually a morbid lesion essential to the disease, or an alteration due to other circumstances, such as the mode of dying, or a mere cadaveric alteration. The late Mr. Wilkinson King, of Guy's Hospital, used to remark at the post-mortem table, whenever there was an examination of a case of death from tetanus: "Gentlemen, we will now proceed to give you a demonstration of a case of healthy anatomy, for there will be no visible morbid appearance, otherwise than congestion of the organs in various degrees, which are owing to accidental circumstances."

We shall, however, cursorily survey the more prominent conditions that are met with:

The body is usually found rigid, and the muscles firm and contracted, and occasionally ruptured, but in some there is no rigidity at all.

The nerves at the seat of the wound may be found inflamed, injected, irritated, lacerated or punctured; yet in other cases perfectly healthy and uninjured; and in one case the divided nerve had reunited and was not inflamed.

The condition of the brain has been found to be healthy, firm, congested, darker than natural, pinkish, &c.

The medulla oblongata has been likewise found in a healthy or congested state; but some observers have noticed a change in the density and specific gravity of different portions of the spinal cord. The specific gravity was found increased throughout, and generally about the region of the cord which was in immediate communication with the nerves of the wounded parts. In the idiopathic variety this change was found throughout the whole cord. Dr. Copland is rather in favour of post-mortem evidences of morbid changes in the spinal cord, medulla oblongata, and membranes. He says: " These changes are rarely altogether absent when the inspection is made twenty-four hours after death; and in no inspection which I have witnessed have inflammatory appearances in one or other of these parts been wanting."

The sympathetic system has been thoroughly examined; in some it was found healthy, and in others slightly injected. Dr. Copland, in 1822, suggested it to be the seat or pathological cause of tetanus; but, as he says, " it must not be overlooked that the ganglia are often very vascular even in health."

The blood is generally found uncoagulated; but in other instances the blood in the heart has been found firmly coagulated, the coagula extending up the arteries and decolorised. There has been no satisfactory examination of the state of the blood, either pathologically or chemically.

Much stress has been laid on the state of the heart, as a means of diagnosis of death from tetanus; but it may assume every possible condition, and is generally only an indication of the mode of death of the individual.

In one case, that of a boy, æt. eleven, who died of acute tetanus, the voluntary muscular fibre under the microscope was found very granular, resembling that of the heart undergoing degeneration; otherwise, in the majority of cases, no change has been found in the muscles.

The lungs, larynx, and alimentary canal present no other appearances but what are due to accidental causes and the modes of dying.

From the foregoing remarks on the morbid anatomy, it must be understood that the pathology is still involved in great obscurity. Some affirm tetanus to be an irritation of a peculiar kind, and affecting the excito-motory apparatus; that the irritating cause may be eccentric at the extremity of, or in the course of the afferent spinal nerve, or it may be centric within the spinal canal itself. Some consider it to be an exaltation of the polarity of the cord and medulla. Others, again, maintain it to be identical with inflammation of the spinal cord and medulla oblongata, and adduce cases of inflammation of such structures as inducing symptoms of tetanus.

It has been suggested that it is due to a morbid condition of the blood, inasmuch as it resembles in some respects those diseases which are produced by poisonous agents, as strychnine, hydrophobia, the poison of woorara, &c.

Dr. Copland justly observes:* "If the difficulty of ascertaining pathological conditions, upon which all rational indications of cure should be based, be so great in this malady as not to have hitherto been overcome, can it be a matter of surprise that the means which have been resorted to, both by physicians and by surgeons, in its treatment, have been most opposite in their effects, the most different in their natures, and in every respect most empirical and uncertain? In this state of our knowledge, it would be better to leave nature to her unaided efforts, to observe closely and accurately what is the true procession of changes and of their manifestations, and to ascertain the seats and the extent of lesion, as soon after death as may be attempted with propriety."

It will be well, however, shortly to enumerate the several methods of treatment that have been adopted and recommended. Each and all have had their advocates, inasmuch as recovery has taken place after their use, and the disease has been considered to be checked in consequence. It is questionable in the extreme, as to the agency and potency of remedies successfully employed in isolated and rare instances, when these same are utterly powerless in the majority of other cases so treated. Of the *local treatment* which has been had recourse to, the following may be enumerated: Incising and laying open the original wound, and removing all extraneous and irritating substances; amputation of the limb; division of the nerves at or about the seat of the wound; the local application of numerous counter-irritants, sedatives, anti-spasmodics, mercurials, &c.; the application of leeches, cold, aconitina, belladonna, &c. to the spine; various topical remedies to the abdomen and region of the diaphragm; warm, cold, and shower baths; electricity and galvanism.

The constitutional treatment. Almost every internal remedy has been successively tried, and no one individual medicine has been singled out as an appropriate means of cure: thus antiphlogistics, including blood-letting, purgatives, calomel, antimony, colchicum, &c. have been extensively used; alteratives in the shape of the varied preparations of mercury, large doses of fixed alcalies, solutions of arsenic, &c.; diuretics, in the form of tincture of cantharides, oil or spirits of turpentine, given in frequent and large doses, so as to irritate the urinary passages or to occasion bloody urine; sedatives, such as digitalis, tobacco, nicotina, hydrocyanic acid, aconitina;* anodynes and narcotics, as opium, morphia, belladonna, colchicum, cannabis indica, ether and chloroform internally and by inhalation; stimulants and antispasmodics, including musk, ammoniacum, camphor, turpentine, assafœtida, castor, wine and other stimulants; tonics, such as quinine, bark, strychnia, iron, zinc, &c.; hygienics and dietetics, as support, milk-diet, &c.; injections into the veins of solutions of opium, stramonium, &c.; tracheotomy and laryngotomy.

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* Art. "Tetanus," *Dict. Pract. Med.*

We do not intend to offer any remarks on the foregoing remedies, but merely add that we can hardly call the above medicines administered, even although attended with recovery, "remedies;" they appear, for the most part, to have little or no specific action in the control of the disease. Those remedies, which have had a more direct influence, have been such as have rendered the patient more able to fight against the battle of spasmodic action. We must recollect that tetanus runs a certain course; it has its period of accession, its height and intense activity, and its gradual decline. It often kills by exhaustion during its decline. Nothing seems to check its regular course; there is no control in its unvarying and too often fatal career; it will have its sway. All we can do is to enable our patient to weather out the storm by giving him as much strength as possible, and not adding fuel to the fire by all sorts of applications and internal remedies which have over and over again signally failed. If we can help our patient on one day after another, we gain much; constant watching and constant attention are required, by night as well as by day; an unflinching perseverance on the part of the sufferer in carrying out these views; besides the avoidance of all causes of excitement, and more especially the cold air or winds; taking care to preserve an uniform temperature as much as possible.

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* See cases of recovery by Fleming's tincture of aconite, *Brit. and For. Med.-Chir. Review*, 1859, vol. xxiii. p. 486.

The following apposite opinions are here quoted:

John Hunter thus sums up his views on the treatment of tetanus:* "All the antispasmodics have been given, but without apparent success; opium has kept its ground the longest, but with little reason, as it only quiets; but from some patients having got well under its use, its name has been raised; I have tried it, both in large and small doses, though always unsuccessfully. I think medicines have no power without they produce some visible effect. Opium never removes the cause, though it will prevent the effects; it cures spasms and removes pain, but it does not remove the cause. It often does good, by not allowing the symptoms to do harm to the constitution. The first appearance of a cure is a recovery of strength, as weakness is a predisposing cause; and the first indication should be to strengthen the system. I know of no internal medicine."

Again he remarks, when treating of constitutional diseases from local irritation:† "As these diseases which I have brought into this class are of such various kinds, each must be taken up apart, and treated accordingly; but they are such as yield very little to medicine, for in some the constitutional disease is formed, and does not require the presence of the local disease to keep it up, as in the tetanus; and in others, the local disease being still in force, it is not to be expected that the constitutional affection is to be entirely relieved, although in some degree it may. In those which form a regular constitutional disease, such as an ague, although the local disease may still exist in full force, yet some relief may be expected; the bark is to be administered, although not with a view to cure, as the immediate cause still exists; but bark will in some lessen that susceptibility in the constitution, and may cure, at least for a time, as I have seen in agues arising from fistula in perineo."

Travers observes:‡ "Now the treatment of tetanus admits of the employment of two classes of remedies, relaxants and tonics. They are in no degree incompatible, but common sense would lead us to endeavour first to calm a wrong action, and having succeeded in calming it, then to apply our tonic for the restitution and preservation of the right one. Perhaps the tonic may be the calming power we ought to employ in a case so rapidly destructive to life as the really acute tetanus; but our limited experience does not warrant the conclusion."

We cannot finish this article without adverting to the recent attempts at cure by means of the woorara poison. Mr. Morgan, in his work on tetanus, offered the following suggestion as a means of cure in this disease. He writes: "There is a close analogy between tetanus and some other spasmodic affections produced by the inoculation of poisons. Almost every symptom of tetanus may be produced in animals by a poisoned wound from chetik, a species of strychnos. It occurred to me, that if I could obtain an equally active poison which produced diametrically opposite effects, I might be able to control the effects of the one by the operation of the other (*contraria contrariis*). The ticunas or wourali was found to have this effect, and I could readily control the severity of the spasms and prolong life by the subsequent inoculation therewith. In more than one case I have perfectly restored the animal to health by bringing this antidote into operation as soon as the first effects of the chetik were observed, and regulating its after consequences by partially or altogether cutting off from time to time, by means of a ligature, all nervous communication between the wound into which it was inserted and the brain. In all cases I took care to insert a quantity of tetanic poison more than sufficient to destroy life, provided no remedies had been used." But it is only within the last two years that this plan has been carried into effect. An Italian surgeon was the first to use woorara; he employed it in three instances, applying the poison in solution to the wounded part, and, where no wound was present, to a raw surface artificially produced by blisters. In two of his cases the tetanus was acute and traumatic, but both died; in the third case the disease was chronic, and recovery ensued. In Paris, likewise, three cases have been experimented on, and with the same result. So also in London, two acute, and one chronic or subacute case, have been treated by woorara, and recovery only effected in the latter case. Thus, of nine cases in which woorara has been employed, six were acute, and terminated fatally, and three were chronic or subacute cases, which recovered. Now this is not at all satisfactory; for chronic or subacute tetanus is a recoverable disease; not so acute tetanus, and it is here that a remedy is anxiously sought for. Woorara has at present not fulfilled its purpose.

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* Hunter's *Works*, by Palmer, vol. i. p. 588. † Ibid. vol. iii. p. 437.

‡ See Travers on *Constitutional Irritation*.

ALFRED POLAND.

DELIRIUM TREMENS.

THE name "Delirium Tremens," which, like so many others used in medicine, has been objected to on account of its want of scientific accuracy, is, perhaps, on this very account, the best that can be adopted to characterise a disease with the real pathology of which we are yet so little acquainted. Like many other affections of the nervous system, it is marked by symptoms so well defined as to leave us in no doubt as to its reality, while they also serve to distinguish it from other forms of disease with which at first sight it might be supposed to be closely allied. Half a century has scarcely elapsed since it was first discriminated from the delirium caused by inflammation of the brain; and since that time, though much has been written on the subject, yet its pathology is so obscure that the most opposite modes of treatment have been recommended for its cure.

The first distinct notice of the complaint is contained in a pamphlet published by Dr. Pearson of Newcastle in 1801, reprinted in the *Edinburgh Medical and Surgical Journal* in 1813,* soon after the appearance in that periodical of papers on the same subject from the pen of Dr. Armstrong.† In the same year the attention of the profession was more generally attracted by the publication of Dr. Sutton's treatise,‡ who strongly advocates the same views as those enunciated by Dr. Pearson.

The successful issue of cases treated on a wholly different plan, subsequently published by other writers, serves only as an illustration of the principle which ought never to be lost sight of in weighing the merits of opposing views, viz. that in a large number of instances disease has a tendency to run a natural course and to terminate in recovery; and that consequently the so-called "cure" takes place, not because of the treatment adopted, but either quite independently of it, or even in spite of its being unsuited to the particular case to which it has been applied. Another source of error in drawing conclusions from the result of particular cases, to which we shall have to allude as we proceed to the consideration of remedies for this disease, is to be found in the dissimilarity which exists among the various examples presented to us. This may be verified by the very great difference in the mortality at any of our public hospitals at different periods, although the treatment may remain practically the same.

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* *Observations on Brain-fever*, by Samuel Burton Pearson, M.D.; *Ed. Med. and Surg. Journal*, vol. ix. p. 326.

† Ibid. pp. 58, 146.

‡ Tracts on *Delirium Tremens*, on *Peritonitis*, and on the *Gout*, by Thomas Sutton, M.D.

Pathology. The real nature of the affection has by no means been made out by morbid anatomy. The post-mortem appearances only reveal to us the mode in which the fatal termination arrived; they throw no light on the origin of the disease, or the morbid conditions on which it is dependent. We know not in what way the nerve-structure is altered by continued habits of dissipation; or how the blood, contaminated by the frequent introduction of alcohol into its current, serves to excite in the deteriorated brain that peculiar delirium, tremor, and insomnia, which so distinctly mark the disease at the bedside of the patient. The condition is one to which we are almost disposed to apply the term of "disordered function," because the evidence of the disturbed action of the organ is so much more distinct than that of the change of structure which no doubt goes along with it. This is more or less the case at present with all diseases of the nervous system, in the minute investigation of which so little progress has been made.

Still, the information derived from anatomical research is worthy of study, because, as it tells how death is actually brought about, it offers suggestions as to how the fatal event may be prevented or warded off. The striking appearance is that of excessive serosity, whether contained in the ventricles, or under the arachnoid, or pervading the whole tissue of the brain, so as to give rise to the term so commonly in use of "wet brain." Occasionally turgidity of vessels is observed; but this is much more rare as a pathological fact in cases of simple delirium tremens, and may, not without reason, be alleged to have been produced by injudicious treatment. Congestion of the brain is the invariable result of opium-poisoning, and here too we occasionally meet with serous effusion. This circumstance it is which gives importance to the objections raised against its administration in delirium tremens; but it may be remarked that the turgidity of vessels and the effusion of serum stand to each other in an inverse ratio in the two cases; in the one congestion often occurs without effusion, in the other effusion without congestion, even when opium has been given freely.

Another cause of congestion sometimes comes into operation, viz. the employment of means of restraint. The struggles of the patient to be free from an impediment which he cannot understand, hurries the heart's action and interrupts his respiration, and thus very materially promotes venous congestion. It is therefore the duty of the practitioner to watch very closely the effects of such measures where he is under the necessity of having recourse to them.

Clinical study alone furnishes us with data on which we can rely in forming any notion of the true nature of the disease; and there seems no reason why, with caution, correct inferences may not be drawn from this source when anatomy fails as a guide. First, it is to be remembered that the disorder is not brought about by a first debauch; that a necessary element in its causation is the *habit* of dissipation. This habit is not to be measured by the actual quantity of stimulants taken by the individual: a patient in whom the nervous centres are easily acted on becomes excited and tremulous, "nervous," as it is often called, by very small quantities taken daily at unsuitable times; while in some remarkable cases two or three bottles of ardent spirits have been consumed every day for months, or even years, before the disease has been developed. Occasionally cases are seen in which the habit having been for a time restrained by circumstances, delirium supervenes immediately on excessive intoxication; and while these present many analogies to true delirium tremens, they differ from it not only in the more marked features of the attack, but also in this important fact, that the delirium is excited by the intoxication. Most writers have pointed out the necessity of such a distinction with reference to treatment, and it has been not inaptly called the *delirium ebriosorum.* This class of cases is that to which alone the view is applicable that alcohol acts as a direct poison, like belladonna or stramonium; and that the delirium is in the one case, just as in the other, due to the presence of a material poison introduced into the circulation from without. But even in such instances the antecedent is still essential; the habit, though restrained by circumstances, must have existed; the first steps in the downward progress of habits of intoxication may lead to nearly complete stupor, but they never give rise to delirium. The delirium is unmistakable evidence of a prior change in the nerves or the blood, or more probably in both together.

Secondly, we have to take into account the exciting cause of the attack. Sometimes it commences in a person habitually intemperate, after a recent debauch during which little solid food has been taken, the appetite being lost, and the stomach in a state scarcely capable of performing the function of digestion; and we are led to the conclusion that the want of healthy nourishment is the main cause of the disorder. But it is very usual to find in such cases that there has been also some great mental anxiety, which has very probably led to the excess in the vain hope of "drowning care;" and this mental condition is not without its influence also in producing the result, even without any very unusual amount of dissipation; the sleeplessness produced by mental anxiety, and the exaggeration of that nervous depression under which drunkards in their sober moments so constantly labour, are of themselves sufficient to hurry on an attack of delirium when the patient is already prepared for it. Next in frequency are those cases in which delirium tremens follows on an accident or injury attended with nervous shock, or supervenes in the low forms of erysipelatous fever, and the unhealthy action of the reparative process in wounds, so constantly to be seen in persons of intemperate habits. In other instances, again, the disease arises under circumstances in which the usual amount of stimulus has not been obtained, and it has been too hastily concluded that its sudden withdrawal had acted as the exciting cause in these cases. The records of our various prisons, in which so many committals occur among habitual drunkards, would seem to negative such an idea; and we are constrained to look rather to the circumstances to which the forced abstinence is due, such as privation or illness with their accompanying mental depression and want of food, as being more likely to have excited the attack than any diminution in the quantity of stimulants taken by the individual.

Thirdly, the clinical investigation of the disease has clearly led to the conclusion that it is one of depressed, and not exalted, vitality. The softness of the pulse, the muscular tremor, and the copious perspirations, are all so many proofs that there is no inflammatory action going on. In former days, when the presence of delirium led to its being classed among inflammations of the brain, and antiphlogistic treatment was consequently adopted, the mortality was frightful; and many of the older writers have spoken both of sweating and tremor as being of the worst omen in phrenitis, wholly unaware that these were symptoms of a different disease. For them they were only indications that antiphlogistic remedies would be ill-borne, and that if already adopted, they must be abandoned. With the knowledge obtained by post-mortem examinations in more modern times, any idea of an inflammatory origin has been wholly abandoned; the wet brain of the drunkard is no longer regarded as a "very dangerous modification of meningitis," which exhibits none "of the actual results of inflammation."*

We are warranted by these observations in assuming, 1st, that the disease is one of exhaustion, in which, whatever be the change which has actually passed on the nervous system, the first indication for the practitioner is to guard against the approach of death by sinking or by coma, in consequence of passive effusion into the brain. 2d, that it is not a direct form of poisoning, in which a few hours will serve to eliminate the poison by some secreting organ or other, after which the patient will be in perfect health, as happens in opium-poisoning, or in intoxication (alcohol-poisoning); but that some obscure structural change has been wrought, and whether alcohol be present in the blood or not, there must have been some additional cause which has produced the delirium, and this generally of a depressing kind. 3d, that, so far as the nervous system is concerned, the condition is such as we might expect to be generated by depressing causes, and its character and mode of treatment ought therefore to correspond rather to those forms of insanity which depend on similar conditions, than to those which are characterised as acute mania.

Diagnosis. With reference to diagnosis, it is to be remembered that the history of the case is very often defective in the most material point—the indulgence of evil habit. Neither the patient nor his friends are quite willing to confess to that of which their better feelings make them ashamed; but while the knowledge of habitual excess gives certainty to the diagnosis, the disease may no less be developed in persons who may be thought by their friends to be very moderate in the use of fermented liquors, and yet who have taken more than their nervous system could tolerate. Very often the trade or occupation of the patient supplies this link in the chain of evidence by showing that he has been placed in circumstances of temptation; and if loss of appetite be at the same time complained of, the inference will generally be correct that the temptation has not been successfully resisted. It has been alleged that delirium tremens may be brought on by the habitual use of opium; and Dr. Watson speaks of a medical gentleman of temperate habits who was on the verge of delirium tremens from mental excitement and anxiety. Of the action of opium on the nervous system, in its habitual abuse, we fortunately know little in this country, and whether the one habit can produce the very same condition of the nervous system as the other, it would be idle to speculate; but it does seem unwise to employ the same name to designate forms of delirium, accompanied by muscular tremor, occurring in persons of known temperance. Such a condition may be seen in cases of severe typhus; indeed, in rare examples, so close is the resemblance that a superficial observer may be readily deceived before the patient is put to bed and the mulberry rash discovered. Not unfrequently the delirium of erysipelas or of rheumatic fever presents features closely resembling delirium tremens; but it is only in the intemperate that the genuine disease is developed. This view may be regarded as an over-refinement; but in our ignorance of its real mode of causation, it seems unwise to class under the very same category cases which are dissimilar in this important antecedent; and it is safer to speak of them as analogous than as identical, especially when a closer scrutiny very generally discovers also some dissimilarity in the symptoms present.

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* Abercrombie, *Diseases of the Brain*, Part I. sect. iv. § 8.

Next in the order of events comes the exciting cause, which may act either primarily on the mind or on the nervous system, as the organised structure through which mind reveals itself; just as in the analogy of other forms of disease we see acute mania brought on by mental excitement, and delirium in phrenitis or in fever produced by actual change in the brain or in the blood with which it is supplied. The character of the exciting cause has but little importance in the diagnosis of the disease; but is deserving of especial consideration with reference to treatment, because the great fact that it is always of a depressing kind forbids the employment of lowering or antiphlogistic remedies.

The actual attack is usually ushered in by sleepless nights and restless days, and there is almost always more or less of febrile disturbance. Exceptions to this rule more especially occur in surgical practice; and sometimes when every thing seems to be going on favourably, delirium suddenly commences almost without warning. In all cases of severe injury in persons of intemperate habits, the surgeon must be prepared for such an event, and must guard against its invasion by husbanding the powers of his patient, and sustaining his strength from the first by suitable nourishment and the judicious employment of stimulants when necessary.

The actual features of the disorder are so striking, that very little experience is sufficient to render its discrimination by no means difficult. The chief points to be observed, in addition to those derived from the history of the case, are the following:

1. *The character of the delirium itself.* This is especially marked by the presence of one dominant idea, which has generally something of unpleasantness mixed up with it, and excites the individual to constant activity. It is, as denominated by Dr. Watson, essentially a "*busy* delirium." The patient is either harassed by some worry connected with business, or he is alarmed by the presence of some loathsome or horrible object, and he is in constant agitation to get this business-matter arranged, or to rid himself of the object of his alarm. He is perpetually jabbering on this one subject, and getting out of bed, or pulling his bed-clothes about, under the influence of the same predominant idea, which from time to time changes from one thing to another. But there is no violence or maniacal excitement; he has no tendency to injure himself or others, and his only risk is that of getting out of the window by mistake, or rushing out of doors in his night-shirt in pursuance of the idea which rules him for the time being. Still he is generally managed with comparative ease by any one who combines firmness with gentleness, and only frets and rebels against unnecessary restraint or harshness. During the earlier periods of the attack he will generally put out his tongue, answer questions put to him, and do as he is directed; and there is none of the incoherent rambling and muttering of words without meaning and connexion seen in other forms of delirium; it is only when the brain begins to be oppressed by serous exudation that such symptoms are seen.

2. *The existence of tremor along with the delirium.* This feature is so marked that it has given its name to the disease. It is not that seen in the weakness and utter prostration of fever when there is delirium and subsultus; it is more allied to the nervous trembling of a very excitable person under the influence of some mental impression, which for want of a better name we call "nervousness," strangely modified, however, by the peculiar restlessness of the delirium which it accompanies. The patient is constantly on the move, and every movement is made in the same tremulous unsteady manner. Even before the delirium has actually commenced, or during convalescence, there is a peculiar hurry and agitation about his actions; he puts out his tongue, or thrusts forward his arm for his pulse to be felt with a jerk, or he rises up in bed with a bound; there is a want of steadiness and deliberation in every thing that he does. This combination of hurry and unsteadiness is one of the

most decided evidences of the approach of the disorder, before any thing like delirium is seen.

3. *Restlessness and want of sleep.* These, though not peculiar to this form of delirium, are its invariable concomitants. The predominant idea keeps the patient in a constant state of imaginary employment; he is no sooner persuaded to lie down than he is up again, or, if he remain in bed, he is perpetually pulling about or arranging his bed-clothes with the same object. Sleep, under such circumstances, is wholly impossible; but no doubt there is more than this, for sleeplessness generally precedes the delirium; and it is only in exceptional cases that this indication is wanting. In other forms of delirium, insomnia generally follows the existence of delusion, whereas in delirium tremens it very often precedes it for several days.

4. *A condition of general depression of the vital powers.* This is perhaps the most important point in the consideration of the disease, because, while it gives certainty to the diagnosis, it also indicates the true line of treatment. Its importance, as one of the sources of our knowledge of the pathology of this form of delirium, has been already pointed out, and this knowledge becomes in its turn the only basis of sound and rational treatment. It is not enough to say that an habitual drunkard is suffering from delirium with some amount of tremor, and that therefore a certain routine practice must be adopted in his case, for his condition may be the direct effect of a recent debauch, while the blood is still poisoned by a large quantity of alcohol, which is producing irritation of the brain and congestion of the liver; it may, in short, be the *delirium ebriosorum*, and not true *delirium tremens*, and the treatment suited for the one may be useless or injurious to the other. We must go a step further, and inquire into the condition of the pulse, skin, and tongue; whether they indicate febrile action of an inflammatory or, at least, congestive kind, or whether they prove that the condition is one to which these names are wholly inapplicable. The pulse may be indeed, as in most conditions of debility, more frequent than in health, but the skin is not dry or burning; it is usually covered with moisture, and the perspiration occasionally becomes very profuse. The tongue at the same time is seldom dry or brown; sometimes it is tolerably clean, more commonly coated with a moist whitish or creamy fur, and having a flabby or œdematous aspect. Dryness of the tongue or redness at its tip and edges, with a roughish fur on its dorsum, may be regarded as pointing rather to the delirium of over-stimulation than to the genuine type of the disease. The

absence of heat of head, the freedom from local pain and uneasiness, and the dilatation of the pupil, all serve as so many distinct indications that the disorder is nowise related to phrenitis, with which there is now hardly any excuse for its being confounded. The conjunctivæ are very often suffused just as they are in typhus, a disease, like it, of a depressing kind, the analogy to which has been already referred to, and did not escape the observation of Dr. Pearson.*

Treatment. The opposite views of the treatment of delirium tremens taken by various writers is at first sight very unaccountable. The explanation, however, is to be found in the absence of any pathological data as to the exact nature of the disease, and in the empirical nature of our practice. It may indeed be to a certain extent called a rational empiricism, inasmuch as we know both the usual causes of a fatal result, and the invariable mode of recovery by sleep. To avoid the one, and to aid in the production of the other, is the rational aim of the medical practitioner, and the discrepancy of opinion has in great measure arisen from too exclusive regard being paid to one or other of these parts of treatment.

The evidence of the older writers is clear and distinct on one point, viz. that when it was mistaken for phrenitis, and treated by depletion and antiphlogistic remedies, the mortality was very much greater than when the distinction had been made and the treatment by opium introduced. It is not possible to trace the causes which led to this change in treatment. Dr. Sutton attributes the discovery to accident; he offers no theory to account for its success, but claims for it the same confidence among the profession generally with which its success had inspired himself. The reaction which, to a certain extent, has taken place, may be ascribed to the indiscriminate manner in which the drug has been subsequently administered, as compared to the caution used by its earlier advocates. The cases furnished by the opponents of the treatment by opium prove clearly that in many instances simple attention to the functions of digestion and elimination, with good management, is sufficient to insure a recovery, and that opium may sometimes at least be dispensed with.†

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* Op cit.

† See especially *Clinical Illustrations of the Pathology and Treatment of Delirium Tremens*, by Prof. Laycock; *Ed. Med. Journal*, vol. iv. p. 289, 1858-9. But it may be remarked that few of the instances there recorded present such a degree of severity as very often marks the disease in this metropolis. Perhaps something is due to the different stimulant in common use in Edinburgh.

In the *earlier stages* of the affection, when the case is only marked by anorexia, disorder of stomach and troubled sleep, its further progress may very generally be arrested by remedies calculated to restore the functions of the stomach and liver, and to evacuate the morbid matters which we know must have accumulated in the blood by long habits of dissipation. At the same time the strength of the patient must be sustained by proper nutriment, and powerful cathartics must be avoided. A patient threatened with delirium tremens cannot bear any decidedly lowering treatment; for, as has been already shown, the exciting cause of the attack is most frequently of this kind; abstinence from food generally plays a very prominent part in its development.

These indications are perhaps best fulfilled by the administration of small doses of blue-pill, followed by a warm and mild aperient; nitric acid in combination with bitter infusion, with the adjunct of some stimulant diuretic, is often highly beneficial; sometimes even more powerful tonics may be usefully administered, such as quinine and mineral acid. When the red edge of the tongue and tendency to vomit indicate a more irritable state of the stomach, which is probably produced by the direct action of the stimulant on its mucous membrane, effervescing draughts with an excess of ammonia are to be preferred to remedies more decidedly tonic; while the irritability is soothed by the application of a sinapism to the epigastrium. The great object of treatment is to enable the patient to take and to assimilate a sufficient quantity of proper nourishment; without this the disorder will get worse. And here perhaps lies the greatest difficulty. Solid food is absolutely refused; even soup or beef-tea may cause such a loathing that the patient cannot be persuaded to take them, or they may be rejected by the stomach. In such circumstances, the feeling of prostration causes him to have recourse to some stimulant as the "only thing which will stay down," and this again increases the anorexia. Sometimes, indeed, the medical attendant feels the same necessity if he would ward off the attack; and then good ale or porter, or even wine, are to be preferred to spirits, as containing some amount of nutriment; and it should be made a *sine quâ non* in granting the indulgence that some solid food be taken with the beer, which should be given only at stated intervals, and not taken as fancy directs. Along with these measures, the nervous agitation is decidedly calmed and the exhaustion of want of sleep may be avoided, by giving a morphia draught at bedtime.

When *delirium* has fairly set in, we ought to ascertain, if possible, how long it has lasted, because it is almost vain to hope for the immediate occurrence of sleep, however large the dose of opium may be. The same quantity of opium which has failed the first day may be completely successful the second. If no treatment has been previously adopted, it is wise to commence with a dose of calomel, which should be accompanied by a grain and a half or two grains of opium, followed after some hours by a purgative. Congestion of the liver is so common with drunkards that the function of this organ demands our first attention; but caution must be exercised that the patient is not too much depressed by the remedies. An effervescing saline with excess of ammonia, and a few drops of laudanum, may be given every second or third hour, with a view to calm nervous excitement and moderate the restlessness of the patient. Whatever food can be taken is to be allowed; and according to the state of the pulse, more or less of some stimulant may be given from time to time. In these matters the attendant must be very much guided by the whim of the patient, the object being to sustain his strength; this must be done in the best way that the circumstances of the case will admit of, but over-stimulation must be carefully avoided. The idea that stimulants can cure the disease has no warrant in experience; and theoretically we may assume that if they do not prevent its occurrence in a man whose habits are those of constant indulgence, and who has been but lately under no restraint, they cannot cure the complaint when the same person is brought into the wards of the hospital. A full dose of some form of opiate should be given at bed-time, and repeated once or twice, even when we do not expect sleep to follow, because the delirium is always aggravated at night.

But unquestionably the moral management of the patient is the point of most importance in practice. Coercive measures are always prejudicial, and are only justifiable under the most unavoidable necessity. The patient may almost always be controlled by firmness combined with a soothing and gentle manner, if his fancies be humoured and not contradicted. Much stress is justly laid by the older writers on this part of the treatment, and it has been unfortunately too much lost sight of in modern practice. Opium and the strait-waistcoat have been sanctioned in hospital practice, from the difficulty of treating such cases in a ward under the superintendence of a single nurse; but it is to be feared that sometimes a fatal termination may not without reason be charged against the treatment, and the opium has borne the blame when the forcible restraint was really more in fault. Dr. Pearson's notes on this subject are quaint and instructive, although few would be disposed to follow out to the letter the various injunctions laid down. Perhaps the arguments against the treatment by opium would have found fewer supporters but for the neglect of such an important element of success.

But while it is the great aim of the practitioner to procure sleep, he must not be tempted to give more opium than his patient will bear, and so complicate the case by superadding narcotic poisoning to the state of delirium tremens. It is better in the progress of the case to intermit its use for some hours, or at least to revert to smaller doses for a time, deferring the repetition of larger doses till night comes on, when he may again attempt by two or three full opiates to produce the effect. Caution is especially called for if there be contraction of the pupils, which, as it is not a usual condition in delirium tremens, points either to an excess of narcotic action, or to already commencing effusion on the brain; and in neither case can large doses of opium be beneficial. Not unfrequently death occurs under circumstances very similar to the effects of narcotic poisoning, and it is not always easy to satisfy the friends that the medicine had nothing to do with the development of the symptoms. In a scientific point of view, it can never be regarded as judicious treatment to push the action of a remedy which, in its operation on the brain, gives rise to a somewhat analogous train of phenomena. The real function of the medical attendant is to obviate the tendency to death, in whatever mode it is most likely to occur.

Whatever doubts may have been entertained in regard to the rules of practice now laid down as applied to the more ordinary forms of delirium tremens, all are agreed that when it supervenes on an accident or injury, or in the course of an attack of erysipelas, the safety of the patient depends upon free stimulation and the exhibition of opium. In very many cases it is vain to talk of what may be the most scientific mode of treatment, because the patient cannot be persuaded to submit to it; but he may be induced to take some form of stimulant, such for example as a draught of porter, in which we may disguise a dose of laudanum to calm his wild excitement; and if it do no more, it at least helps to ward off fatal syncope, and gives nature time to do her own work in her own way.

Very recently attention has been called to the possibility of introducing narcotic substances into the cellular tissue, by what is called the "hypodermic method," in cases in which they have seemed to fail in producing their effect when taken into the stomach. Instances are recorded* in which this practice has been adopted in delirium tremens; and without claiming for it an invariable success, it is well to bear in mind that the assimilating powers of the stomach are always much interfered with; and that consequently, while the remedy itself is very likely to escape absorption, its presence in the stomach is also apt to increase the anorexia and inability to assimilate proper nutriment, which stands so much in the way of successful treatment. It may also be made the means of bringing the patient under the influence of a narcotic, when his resistance prevents its being administered in the usual way. In either case, the injection of a few drops of solution of morphia under the skin may be practised with perfect safety if due caution be exercised, and is to be regarded as an important adjunct in the treatment of the disease.

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* *Medical Times and Gazette*, 1859, vol. xviii. p. 310, &c.

When there is extreme prostration and the skin is bathed in perspiration, it is not unreasonable to expect benefit from the exhibition of tonics and astringents; personal experience, perhaps rather limited, has seemed to confirm this view. Quinine and acid in full doses, during the intervals of the opium treatment, have certainly been well borne and apparently have done good in such cases.

To sum up: the natural mode of recovery is by sleep, which occurs in the milder cases spontaneously; the object of treatment in the severer cases is to bring about this result by the judicious administration of opiates. Full doses are to be repeated at short intervals for a limited time, and to be again resorted to after the lapse of some hours, if at first unsuccessful. The functions of the stomach and liver at the same time claim especial attention, because they are almost always disordered in drunkards, and the consequent non-assimilation of food is one of the essential elements in the causation of the disease; the strength must therefore be supported by such nourishment as the stomach can bear, and when necessary, by the administration of stimulants, while all unnecessary coercion is to be carefully avoided. The great error in the treatment of the present day seems to be the regarding opium and stimulants almost in the light of specifics, while neglecting other important measures; it consists in the endeavour to "cure" by heroic means, in place of resting satisfied with aiding in bringing about the "recovery" of the patient.

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SCROFULA.

SCROFULA is, in one respect at least, an unfortunate word, for it is not clearly defined. On the contrary, very different significations are attached to it. It has certainly become a vague term, so that wherever met with, it is necessary to refer to the context to obtain an idea of the sense in which it is employed. For example, by some it is applied to a certain state of the constitution, and by others to the disease which results from it. Again, it is often applied to all the diseases which, arising in a certain state of the constitution, possess some general features in common; while it is sometimes limited to the absolute deposit of tubercle, being simply synonymous with the more modern phrase tuberculosis. Finally, the confusion reaches its climax by the introduction of the adjective scrofulous, which is, and perhaps ought to be, if used at all, employed in the same sense as the substantive, but is applied more frequently, at least in conversation, as a less definite term to doubtful cases, when the features are obscure and the diagnosis uncertain.

It is necessary to state, then, that in these pages by the term scrofula is understood a certain disease or defect of the constitution in which there is a tendency to produce and deposit a substance called tubercle in various tissues and organs. Tubercle may therefore be said to be the essential element of scrofula.

But it does not follow from this definition that a deposit of tubercle must necessarily occur in every case of scrofula. That depends upon the extent of the affection, and is determined by various circumstances.

The use of the word in this comparatively restricted sense possesses at least this merit: it gives precision to the term and renders it definite. But it may be said, Then why not make it at once synonymous with tubercle? that would be yet simpler. True; but then some term would still be required to express the state of the system, and none, as matters at present stand, would be so convenient as scrofula.

Scrofula, or struma (which is a synonymous term), is therefore generally identical with tuberculosis; the use of the latter term, however, being often restricted to the case in which there exists a deposit of tubercle.

What, then, is tubercle, the essential element of the disease? Its characters, as generally recognised, may be thus described: Tubercle, in its proper sense, is a substance not vascular; so far as we know, inorganisable; tending to degeneration; which is either deposited in distinct masses, or infiltrated through the various tissues.

Tubercle is usually described as occurring in two principal forms.

Most frequently as an opaque substance of a dull pale-yellow colour; sometimes tolerably firm, yet friable like cheese; at others, softer, like putty, readily yielding to pressure and smearing the surface on which it is pressed; either accumulated into a distinct mass varying in size from a pin's head to a small orange, or else occurring as an infiltration.

Or very often in the form of small granular bodies, varying in size from a mere speck to that of a millet-seed, or occasionally larger; of a pale-gray tint, translucent, and glistening. The more transparent ones sometimes reflect or refract the tint of the surrounding tissues. To a superficial inspection they appear spheroidal, but when more closely examined, they are seen to possess sharp angles; the circumference is more or less irregular, with short branching processes. Thus intimately connected with the adjacent tissues, they cannot be distinctly isolated. They are always firm, and sometimes hard; the cut surface has very much the appearance of cartilage; they yield little or no fluid when crushed; they tend to accumulate in groups.

The first of these forms is distinguished as the yellow, and the last as the gray, or from its ordinary size as the miliary, tubercle. Between these two cardinal forms any intermediate variety may occur.

The shape which a mass of tubercle assumes is doubtless due to the influence of the parts around. Its name is derived from the fact that it often possesses a tuberiform shape, although Dr. Carswell has shown that this is less common that had previously been supposed. It is seen most frequently in the brain, and also in the cellular tissue. But it may occur in layers, as in serous membranes, or ramiform, as in the bronchi. In short, its shape is determined by the mould in which it is cast.

In truth, tubercle is most frequently infiltrated into the natural tissues; and although the term infiltration is commonly applied to the diffuse form alone, even the circumscribed masses with definite though generally irregular outlines are, as Paget says, equally infiltrated among the natural tissues, only in these the infiltration occupies a defined area.

Hence the reason why a mass of tubercle, although in itself strictly homogeneous, yet often appears otherwise to close observation. Distinct lines and streaks are frequently visible throughout its substance. These are due to some of the tissues of the organ which become enclosed by the deposit of tubercle as it accumulates. In this way blood-vessels and all kinds of structures may be found in a mass of tubercle; and the tissues thus enclosed sooner or later degenerate or undergo other morbid changes.

As a general rule, it may be stated that tubercles which are most regular in shape, spheroidal or tuberiform, as tubercles in the brain, are most uniform in aspect and structure.

A large and irregular mass of tubercle may arise either from continued deposition around a single centre, or by the coalescence into one of several distinct masses. Tubercles in the lung especially illustrate the latter mode, when of any considerable size.

It has been disputed whether tubercle is ever encysted. With reference to this question Walshe says: "We have ourselves never seen encysted tubercle in any structure of the body, if by the term be understood tubercle contained within a cyst, which has acted as its formative organ. But we have seen in very rare instances in the lung, and, comparatively speaking, somewhat more frequently in bone, tuberculous matter surrounded by a more or less complete membrane, strongly assimilable in properties to the pyogenic membrane of abscesses, and, like it, obviously formed consecutively to some at least of the matter it invested. Such we believe to be the key to the comprehension of 'encysted tubercle.'"

The minute structure of both forms of tubercle is essentially the same. They differ principally in the condition and the relative proportion of the different elements.

To the microscope tubercle exhibits various forms. These may be separated into those that are proper to the tubercle itself, and those which are incidental or accidental and derived from the surrounding parts.

As the elements proper to tubercle may be recognised: Shapeless fragments; flakes or shreds of a substance which is sometimes, as in gray tubercle, transparent and almost homogeneous or delicately fibrous; sometimes, as in yellow tubercle, obscurely granular. It swells and becomes more transparent when treated with weak acids or alkalies:

Innumerable and extremely minute molecules and granules, especially abundant in the yellow tubercle, and in it mingled with oil-globules of various size; these are soluble in, and may be abstracted by, æther, and recovered by evaporation:

Corpuscles or cytoblasts of various shapes and contents, but almost all distinguished by being more or less irregular in form. They are shrunken, wrinkled, withered, and appear like defectively-developed, aborted or degenerate exudation-cells. Their contents are generally granular, and now and then something like nucleoli may be discerned in their interior. These corpuscles occur in both kinds of tubercle, but those in the yellow variety are much more deformed and distorted, and their contents are more granular.

In addition to these there are found incidentally: ill-formed epithelial cells in all stages of development and degeneration; masses of pigment; crystals and plates of cholestearine; remnants of enclosed and disintegrating tissue, as, for instance, in the lung fragments of elastic fibre, and rarely small blood-vessels in a state of fatty degeneration.

Tubercle has of course been subjected to chemical analysis, and in some instances with very elaborate results. Amongst other substances, it yields, as would be expected, oil, nitrogenous principles, cholestearine, chloride of sodium, phosphate and sulphate of soda, phosphate and carbonate of lime, magnesia, &c.

As already indicated, tubercle possesses no inherent power of growth. It increases simply by the addition of new matter upon its exterior, or by the gradual coalescence of distinct deposits.

Tubercle when deposited may undergo various changes.

In the first place, can tubercle, when once deposited, be simply reabsorbed? This question would be doubtless very generally answered in the negative. Walshe, however, says that his belief in the occurrence of such reabsorption is firm; and Virchow believes there are rare cases in which tubercles, in consequence of undergoing complete fatty metamorphosis, become capable of absorption: but, although there is assuredly no reason for denying its possibility, the evidence advanced in its favour is yet far from conclusive.

Yellow tubercle, after it has remained firm for a variable period, —the crude tubercle, as it is called,—has a strong tendency to soften. This, in the majority of cases, sooner or later occurs. The process of softening may commence in any part of the mass, and may be either of intrinsic or extrinsic origin. There appears to be no doubt now that the change is sometimes, perhaps usually, intrinsic—a form of natural degeneration, such as may occur in lymph, and by which the softening of fibrinous clots within the heart and veins is effected. Indeed, as exceptional cases, tuberculous coagula sometimes form within the blood-vessels. This process of spontaneous softening usually commences at or near the centre of the mass, "in the part of it which, we may believe," says Paget, "being most remote from the blood, is least able to maintain itself in even such low development as it may have reached." When a tubercle undergoing this change is divided, the softened portion, glutinous, tenacious, fatty, is readily distinguished. It may be pressed out from the firmer portions. As the change proceeds, softened caseiform flocculent fragments float in a thin, yellowish, turbid fluid. By and by the whole may become liquid.

In the liquefied matter corpuscles may still be detected in advanced stages of degeneration, amidst an abundance of molecules and globules of oil. Under these circumstances the large granule-cells appear. The principal changes are, the disintegration and destruction of the corpuscles and the abundant increase of oil-globules. It is fatty degeneration.

But the softening may be of extrinsic origin, and, as it were, accidental. In this case it is due to "the mingling of liquid products of inflammation in the adjacent tissues." Softening from this cause usually commences at the periphery, but sometimes in the central portions, when the natural textures are there enclosed. Pus then becomes mixed with the débris of tubercle.

The liquid thus produced is usually discharged by ulceration of the investing tissues, or it may be retained. The fluid portion is then slowly absorbed, and it dwindles into a putty-like mass, which still further shrinks and hardens.

When the disintegrated tubercle is discharged, either an ulcer or a cavity is produced. In this way vomicæ in the lungs are commonly formed. And these may be extended "through communications formed with softening tubercle on their confines."

It is stated that tuberculous matter is sometimes, though rarely, exuded from the surface of certain mucous membranes without any breach of texture.

Yellow tubercle may undergo what is termed calcareous degeneration, and this even after it has begun to soften. The corpuscles shrivel and wither. The organic matters gradually disappear by absorption, until scarcely a trace remains, and nothing but a cretaceous mass composed of inorganic salts is left behind; and this may be, but is not often, finally expelled. Such cretaceous fragments are sometimes expectorated.

The gray tubercle may also undergo a peculiar degeneration or withering. Rokitansky thus describes it: "After abiding in the primitive crude condition before described, it becomes transformed, with the loss of its moisture—with condensation—to a hard nodule, and shrivels into a tough, amorphous or indistinctly fibrous, horn-like mass, in a word, *cornifies.* This determines a complete wasting and death of the tubercle, subversive of all further change. Occasionally this process is associated with bony deposition, the tubercle becoming a partly cornified, partly ossified nodule." He adds: "this tubercle does not undergo any other metamorphosis independently." But it is generally believed that the two forms of tubercle, the gray and the yellow, represent different stages or degrees of the same disease. The gray is regarded as an earlier condition of the yellow tubercle. This opinion is based upon the following evidence.

As already described, they exhibit, speaking generally, the same structure. It is true that the different elements vary in their relative proportion in the two forms, the corpuscles predominating in the gray, and appearing more normal in character, less degenerate; and the granular and molecular matter being much more abundant in the yellow: but this is a question of degree merely, not of kind, and when considered, constitutes a strong argument in favour of the view.

The gray and the yellow tubercle are often found mingled together. And further, the yellow tubercle often appears in the substance of the gray, and is believed gradually to take its place; and this transformation may be seen in all degrees of progress. Even Rokitansky admits "the combination of the two cardinal tubercle-blastemata in different proportions, and their manifold grades of coordination and of blending." Speaking of the degeneration of the gray into the yellow tubercle, Williams says: "Generally the change begins in the centre of the mass, apparently because, there being no permeating vessels, the centre is the furthest removed from the vivifying influence of the blood." This explanation has been also applied, as previously mentioned, to the central softening—the further degeneration of yellow tubercle.

But it does not follow from this that the deposit of yellow tubercle is always preceded by the gray. On the contrary, in some organs the gray is very rarely seen; in the brain, Walshe says, never. And sometimes yellow tubercles are discovered of the minutest possible size, without any trace of gray substance. Virchow, however, regards the gray miliary granule as the characteristic form of tubercle, and the yellow as the same in a state of fatty degeneration.

With regard to the relative frequency of tubercle in the various textures and organs, I will quote Rokitansky, for his statistics are unrivalled. He gives the following scale:

In adults: lungs; intestinal canal; lymphatic glands, more particularly the abdominal and bronchial; larynx; serous membranes, especially the peritoneal and pleural; pia mater; brain; spleen; kidneys; liver; bones and periosteum; uterus and Fallopian tubes; testicles (including the epididymis), with prostate gland and seminal vesicles; spinal cord; striated muscles.

In children: the lymphatic glands, together with the spleen, would take the lead, followed by the lungs, with the bronchial mucous membrane, the brain, the serous membranes, &c.

But this list includes all formations, whether primary or secondary. A more important question still remains to be answered. In what organs is the primary deposit of tubercle most frequent? Where is tubercle most likely to be deposited in the first instance? I refer again to Rokitansky. "If, which is most important, we consider tuberculoses individually, according to their primitive or to their secondary appearance, an entirely different scale is set up. The lungs and lymphatic glands, it is true, retain their uppermost rank, but are immediately followed by tuberculoses which stand very low in the foregoing scale, namely, of the urinary system, of the female sexual mucous membrane, of the bones, of the testicles, with the prostate gland and the seminal vesicles. Meanwhile tuberculoses of the intestine, of the larynx and trachea, of the serous membranes, of the spleen and liver, take a very subordinate position in the new scale, seeing that they seldom, if ever, become the primary seat of tubercle. Tuberculosis almost invariably attacks several determinate organs concurrently at the outset, or at a very early period."

With regard to the tissue in which tubercle is deposited, he says: "The seat of tubercle, as exudate, is, at any point of any texture, extraneous to the blood-vessels. Wherever there is a capillary range, a deposition of tubercle is possible. The seat of tubercle is without doubt precisely, or at least in close proximity to, the spot of its exudation, its blastema being in the highest degree coagulable. It is most probable, for this reason, that it does not affect textures nourished from a distance by a slow imbibition of their substance with plasma, for example, cartilage. We can ourselves testify to the occurrence, both in the larger blood-vessels and in the capillaries (as depôts or metastases), of coagula obviously of a tuberculous nature."

It is worthy of note that tubercle has generally in every organ some favourite part, some portion especially disposed to the deposit. For example, in the lungs it usually commences at the apex; in bones, in the spongy ones, or in the cancellous texture of others. In some of the cases it is perhaps possible to account for the selection.

What is the nature of tubercle? This great question, second to none within the whole range of pathology, so often asked, so often replied to, yet remains a doubtful one. The highest and best authorities are still at issue concerning the nature of tubercle.

Is it a specific product, and should it be classed with the same order of diseases as cancer? Is it the product of inflammation? Is it composed merely of the elements of dead tissue? Is it a peculiar transformation of tissue-elements coördinate with fatty and the allied degenerations? Has it always an origin from the cellular elements of connective tissue? Is it ever formed by the increase and metamorphosis of epithelial cells analogous to the process of glandular secretion, or rather as a morbid desquamation? Is it simply a degraded condition of the nutritive material? These questions might be multiplied.

It would not, perhaps, be very profitable, and certainly not very interesting, to enter at any length into a consideration of these various questions. Even if desirable, space would fail me were I to attempt a lengthened statement of the grounds upon which these several opinions are founded, and of the arguments opposed to them.

If I may venture to say so, I confess that, as the question at present stands, the facts and arguments in favour of the view that tubercle is a form of degraded plasma, or, more specifically, degenerate lymph, appear to me to outweigh all others.

The grand argument in support of this opinion, which assumes the generally received doctrine concerning exudation to be the true one, is similar to that on which the relation of gray to yellow tubercle, previously referred to, is founded, viz. that all forms and conditions of lymph are met with, from that which is most plastic and susceptible of organisation, to that which is most degenerate,—the gray and yellow tubercle,—and that between these extremes all intermediate gradations are found, so that it becomes impossible to draw a line, which is not an arbitrary and artificial one, at any point, and say that it separates lymph from tubercle.

Nay, more; this gradual transition may be seen even in a single deposit. Rokitansky says, "just as tubercle-blastemata combine with one another, so, in like manner, does organisable blastema enter occasionally into combination with tubercle." And, further, as would be expected, "the combination of gray tubercle with organisable fibrine is more susceptible of proof. The instances are not rare in which, hard by pure gray tubercle, granulations are found, in which one portion of their blastema is in progress of organisation to a fibrous texture, whilst the other abides in its primitive condition, and eventually falls into decadence—cornifies." Again, Schrœder van der Kolk says, rudimentary filaments of newly-formed tissue are sometimes seen among the cells of tubercle.

This holds good even for their minute structure and the elements of which they are composed; as in the two forms of tubercle, it is a question of degree only; the plastic elements predominating in the higher, and the products of degeneration in the lower forms. Paget says: "There are, I believe, no signs by which degenerate lymph or pus may be, in all cases, distinguished from ordinary tuberculous matter. A distinction of degenerate lymph from tubercle may be impossible."

The same statement also applies to the changes which the deposits subsequently undergo. Rokitansky and Paget, when speaking of the degenerations of tubercle, frequently compare them to the degenerations of lymph. Indeed, so far as we know, the process is the same.

But on this account tubercle is not to be regarded, as it sometimes is said to be, as an event of inflammation. It does not follow from this that inflammation must necessarily precede its exudation. It may be, and doubtless is, often an exciting cause; but tubercles are frequently deposited without any evidence, either direct or indirect, of inflammation. If the question be asked, What, then, determines the exudation or deposition of tubercle? the answer may be,—supported as it is by the authority of Rokitansky,—Tubercle, "like other blastemata," may exude insensibly as in the act of nutrition, or as a result of congestion, or as a consequence of inflammation.

But the occasional or frequent connexion which exists between inflammation and tuberculous deposit is another fact in favour of the relation of tubercle to lymph. In certain forms of pneumonia the effused matter which produces consolidation of the lung may have in one portion all the characters of ordinary lymph, and in another the characters of tubercle; and in some of these cases the matter, which cannot be distinguished in any way from tubercle, evidently consists of degenerated portions of the lymph. In different parts this process of degeneration may be traced. A similar condition is frequently witnessed elsewhere. On the other hand, tubercle has no inherent independent power of growth such as tumours possess.

Moreover, tubercle has in its structure no characteristic element. Although Lebert and others have described corpuscles supposed to be distinctive as "tubercle-cells," yet by the great majority of observers these cannot be distinguished from degenerate and deformed exudation-corpuscles, such as are commonly seen, under certain circumstances, in effused lymph. We may therefore speak of tubercle as composed of degenerate and decaying elements.

Dr. C. J. B. Williams—who has for many years regarded tubercle as "a degraded condition of the nutritive material from which old textures are removed and new ones formed, and that in its origin it differs from the normal plasma or coagulable lymph, not in *kind*, but in *degree*, of vitality and capacity of organisation"—divides deposits into three classes. The euplastic; healthy organisable lymph. The cacoplastic; defective in organisability, represented by the indurated tissue which characterises cirrhosis of the liver and that which occasions the opaque tough thickening of the valves of the heart, and seen again often in the dense cicatrices of scrofulous sores. Into the lowest extreme of this class comes the gray transparent tubercle. The aplastic; which includes all the more common forms of tubercle. These divisions, and the terms employed to express them, are convenient and useful; only it must always be borne in mind that they are in one sense artificial, inasmuch as their limits are not naturally defined. For, as Williams says, "every gradation may be found between euplastic and aplastic deposits."

This view of the pathology of tubercle,—its affinity to lymph,—which is a very old one, and received many years since the support of Alison, enables us very clearly to comprehend the relation of the gray to the yellow deposit, and to understand how, by a process of still further degeneration, the transformation ensues; and how it happens that so often the yellow form is at once, in the first instance, deposited, the change in this case preceding the exudation. And in this view tubercle, and the changes it undergoes, are so far regarded, in the light in which Virchow views them, as coördinate with other retrograde metamorphoses, such as the fatty and calcareous degenerations.

Are there any signs by which that state of the constitution which tends to the production of tubercle can be recognised? Does scrofula manifest itself by any other symptoms than the deposit of tubercle? Often, very often; but not always. As a general rule, but subject to numerous exceptions, it may be said that the symptoms of scrofula are the symptoms of debility.

Those who have written on the subject have, for the most part, described at length certain characters of body and mind by which they affirm those persons to be distinguished, in whom the disease is likely to be developed: and usually two varieties are depicted.

In the first, distinguished as the sanguine or serous, there is a general want of muscular development; for although the figure may be sometimes plump and full, the limbs are soft and flabby; the skin is fair and thin, showing the blue veins beneath it; the features are very delicate, often a brilliant transparent rosy colour of the cheeks contrasts strongly and strikingly with the surrounding pallor; the eyes, gray or blue, are large and humid, with sluggish pupils, sheltered by long silken lashes; hair fine, blond, auburn, or red; teeth white, and often brittle; there is frequently a fulness of the upper lip and alæ nasi; the ends of the fingers are commonly broad, with convex nails bent over their extremities. Such persons usually possess much energy and sensibility, with elasticity and buoyancy of spirits; they often possess, too, considerable beauty. In this variety, with the same delicacy, the skin and eyes are sometimes dark.

In the second, distinguished as the phlegmatic or melancholic, the skin, pale or dark, is thick, muddy, and often harsh; the general aspect dull and heavy; hair dark and coarse; the mind is often, but not always, slow and sluggish.

Children especially, in whom the diathesis is strongly marked, are often distinguished by the narrow and prominent chest, the tumid and prominent abdomen, and the paste-like complexion; the limbs are wasted; the circulation languid; chilblains are common on the extremities; the mucous membranes particularly, and, above all of them, the digestive, are liable to morbid action; the breath is often sour and fœtid; the tongue is furred, and the papillæ towards the apex red and prominent; the bowels act irregularly, and the evacuations are unusually offensive; the digestion weak; the appetite variable and capricious. In Dr. Todd's opinion, the "strumous dyspepsia presents a more characteristic feature of this habit of body than any physiognomical portrait which has yet been drawn of it." The relation of disorder of the digestive organs—the subject upon which Abernethy was so wont to insist—to scrofula, was many years ago particularly dwelt upon by Lloyd. There is often a singular assumption of age both in character and appearance; in mind and manners they are prematurely old.

Moreover, persons, and especially children, possessing this diathesis, are very subject to certain affections which are regarded by many as manifestations of scrofula. Such, for instance, as various eruptions frequently seen behind the ears; chronic inflammation of the eyelids and conjunctivæ; a certain form of ophthalmia, described as strumous; chronic ulcers of the cornea, &c.

Now although it is quite true that those who are thus distinguished are especially prone to the production of tubercle, yet it is equally certain that it frequently occurs in others who do not at all correspond to either of these descriptions. In fact, we know of no description of persons in whom we could venture to say that tubercle will not appear, for it belongs to all temperaments. The utmost we can assert is, that in those in whom the characters previously detailed are most strongly marked, tubercle is most liable to occur.

Moreover, some of the characters detailed are so common, that it may be reasonably questioned whether their connexion with tubercle is not merely accidental; while of others more decided it may be doubted whether they are not rather the effects of, than antecedent to, scrofula.

Scrofula is a disease of early life. Its manifestations are very common before, and comparatively rare after, the middle period.

Certain persons, then, are more liable than others to a deposit of tubercle, although it is by no means always possible to distinguish such beforehand. Persons in whom there exists this tendency to the formation of tubercle are said to possess the scrofulous or strumous diathesis. Now the great cause of this predisposition is undoubtedly hereditary. It is transmitted from parent to offspring. Scrofula is, perhaps, more frequently transmitted hereditarily than all other diseases together. It does not follow that the parent must have tubercle in order to transmit the diathesis to the offspring, any more than it follows that the disposition or tendency so transmitted must necessarily lead to the development of tubercle. Indeed, many maintain, with Sir James Clark, that "a state of tuberculous cachexia is not the only morbid condition of the parent which entails the tuberculous predisposition on the children; there are several diseases which have this effect: in short, a deteriorated state of health in the parent, from any cause, to a degree sufficient to produce a state of cachexia, may give rise to the scrofulous constitution in the offspring."

Can the diathesis, if not hereditary, be acquired under any possible circumstances? To this very important question it is, from the nature of the subject, almost impossible to give an unequivocal answer. The causes of disease are conveniently and naturally divided into predisposing and exciting or determining, and the development of disease depends upon the extent to which these causes act in combination. For example, by way of illustration merely, let it be assumed that any given disease cannot be produced unless the sum of the causes reaches a certain figure—say a hundred. Now, so long as this number can be attained by the causes conjointly, it matters not what their relative share in it may be. The predisposing cause may equal seventy, and the exciting cause thirty, or *vice versâ*. From this it follows, as is well known, that when the predisposition to disease is strongly marked, the most trivial exciting cause may suffice to develop it; it may be ninety-nine to one. On the other hand, if the exciting cause or causes be sufficiently intense and prolonged, the disease may be produced when there is only the faintest predisposition. Now the difficulty of answering the question just proposed lies in this. It can never be said of any person that he has no predisposition whatever, that he is proof against the occurrence of tubercle; for tubercle has again and again appeared in those seemingly the most immune from it. Or again, supposing the subject of tubercle to be born of apparently healthy parents; we do not know that the diathesis was not lurking latently in them, wanting only a sufficient amount of exciting causes for its outbreak. For it is commonly believed that a predisposition may lie latent in a generation or two, and appear in the next; moreover, other diseases of debility than scrofula in the parent may probably develop the scrofulous diathesis in the offspring. In short, the question cannot be answered, because it can never be said of any one that he is proof against tubercle; and when tubercle does appear in any one in whom from his constitution and history we should least have expected it, we cannot be sure that he has not inherited the disposition from an ancestor, immediate or remote, in whom nevertheless it may have been latent. "For there is hardly a family," says Dr. Latham, "into which consumption, sooner or later, does not enter." Practically speaking, however, there are no grounds for denying the fact that the disposition to tubercle may be, when not hereditary, acquired; on the contrary, both reason and experience are in favour of the belief: and even were the evidence less convincing than it is, even were the case more doubtful, it would be wisest to act upon the assumption of its possibility.

Of this, however, there is no doubt, that the tendency to the production of tubercle exists in different degrees in various persons. It may be so strong that no skill or care can avert its development. It may be so slight as only to appear under a combination of the most unfavourable exciting causes. What are these? "They may all be ranked together," as Alison says, "as causes of *debility;*" many of them may be regarded, not as exciting causes merely, but as predisposing ones. The chief are—

Insufficient food and improper diet. Watson, speaking of this cause, remarks: "There is one fact which has always struck me as very instructive and convincing on this point. Infants at the breast, supplied with good milk, and with plenty of it, seldom show any signs of scrofulous disorder; whereas as soon as they are weaned they become subject to various complaints of a strumous kind. When an unweaned child is brought to us with ophthalmia, we expect almost always to discover inflammation of the common and acute kind—the purulent eye. In nine children out of ten who come after weaning, we look for and find some form of scrofulous inflammation, such as pustular ophthalmia."

On the other hand, intemperance and excess.

Impure air, whether simply from want of ventilation, being deteriorated by respiration, &c., or impregnated with deleterious gases and noxious vapours.

Exposure to wet and cold, and to sudden changes of temperature. The utmost importance is to be attached to climate. The climate of Great Britain is prejudicial in this respect, perhaps rather on account of its variableness and vicissitudes than from its low temperature, when compared with those regions where scrofula is less common. The influence of climate is shown not only in the improvement which many persons experience when they migrate to warmer and more equable ones, but also in the frequent development of tubercles in the inhabitants of those latitudes when they come hither.

Mental depression. Few causes can rival for mischief anxiety, when intense and prolonged.

Of course these causes are more potent when combined. Certain occupations are mischievous, on account of the circumstances to which those who follow them are exposed. Such, for instance, as working for the greater portion of the twenty-four hours in close and ill-ventilated rooms lighted by gas; exposure to noxious fumes and vapours, or to the dust of stone or metal, or to the night-air at all seasons and in all states of the weather, or to great and sudden transitions of temperature; excessive and continued fatigue, whether mental or bodily; poverty, of course, with all the evils following in its train.

Knowing that the causes of debility favour the formation of tubercle, we can understand its frequent supervention when the powers are depressed by some other disease. Where we have any reason to suspect a predisposition to tubercle, we anxiously watch during the period of convalescence from illness of any kind.

As illustrating the course and local treatment of tubercle, when deposited, the cervical lymphatic glands may be conveniently selected; for of all parts liable to the deposition of tubercle within reach of the surgeon, they hold the first place. In the adult, as we have seen, the lymphatic glands rank next to the lungs and intestinal canal in order of frequency, and in children of all organs they stand first.

Now these glands are sometimes the seat of common inflammation and suppuration, and this may occur even in those who possess the scrofulous diathesis. But this is a rare exception to a very general rule; for when these glands inflame and suppurate, it is usually as the result of a previous deposition of tubercle. I believe that the vast majority of those cases which are spoken of as ordinary inflammation of the cervical lymphatic glands modified by the scrofulous diathesis are really due to some deposit of tubercle in the first instance. And certainly the view which has been taken in this article of the pathology of tubercle enables us to understand and reconcile the contradictory statements which appear on this point. For instance, the substance found in the lymphatic glands that one pathologist calls tubercle, another says is only degenerate lymph; while those most conversant with the subject admit that there are certain forms of deposit seen in the lymphatic glands and elsewhere in which the distinction of degenerate lymph from tubercle is impossible. There is certainly, as Virchow remarks, a close correspondence between the cells of the gray granule and the corpuscles of the lymphatic glands; a correspondence, he adds, which is neither accidental nor unimportant. As there are, in fact, all degrees between the most plastic lymph and the most degenerate tubercle, it is clearly impossible, even pathologically, and much more impracticable surgically, to distinguish by any definition the cases which should be called tuberculous from those which are not. Extreme cases are sufficiently clear: it is concerning the intermediate ones that the doubt occurs; and the difficulty is often evaded by describing them as inflammation of the glands occurring in a scrofulous constitution, and modified accordingly.

It is a characteristic feature of tubercle that it is deposited insidiously. Generally it is not preceded by any symptoms which we are able to recognise. We have no warning of the event; no local disturbance in the first instance; no pain at the commencement, and comparatively little at any time. It is often curious to witness the great and singular disproportion between the pain and the local mischief. The first symptom which attracts attention to the cervical glands is their enlargement. Their position is manifested by their induration and prominence. Before they become apparent to ordinary observation, a careful examination of the region they occupy will often detect them slightly enlarged and indurated as distinct and movable kernels along the borders of the sterno-mastoid muscle. At this time the slight change is perhaps due to increased vascularity, which may be antecedent to, or coincident with, the deposition of tubercle; for they will often at this time, under more favourable circumstances, subside and disappear; a happy event, which is by no means a common one when tubercle is once unequivocally deposited.

When tubercle, then, is once deposited, it may either remain, perhaps for a long time, quiescent, or it may continue simply to increase. The adjacent glands, under these circumstances, partially blend together, and sometimes form very considerable and ugly masses in the neck, looking and feeling like small potatoes beneath the surface. Or, after a while, it may undergo calcareous degeneration, as previously described; the organic matter being absorbed, until by and by nothing is left but a small cretaceous fragment in the substance of the gland. Or, lastly, as its usual tendency is, sooner or later it may soften, and so give rise to more active symptoms. Even after the mass has softened, it may still be, and often is to some extent, absorbed; but usually the liquefaction is followed by its discharge. The surrounding parts inflame, and pus becomes mixed with the softened tubercle; the integuments over it become thinner, and "point," and at last give way. This process only differs in degree from the course of an ordinary abscess in the vigour of its action and the rate of its progress. It is altogether more indolent. The inflammation is less intense, and its symptoms much milder. The "pointing" is less concentrated. The matter discharged usually consists of curdy flakes in a thin, turbid, yellowish liquid.

Dr. Latham, in his well-known lectures on *Clinical Medicine*, has graphically described this process of softening and expulsion of tubercle in the cervical glands as an obvious illustration of what so often occurs elsewhere in parts hidden from our view. He divides such cases into two principal classes. In the first there is only a necessary amount of inflammation excited, just sufficient to accomplish the result, and which subsides as soon as that is effected. This, he says, is called the "specific limit" of the disease. "By this is meant the limit proper to its local morbid action, which, for any purpose it has to accomplish, it never need to transgress." In the second case the inflammation may spread beyond its specific limit, and become much more severe and extensive than is needed for the mere elimination of the tuberculous matter. It may extend widely and deeply. This distinction is of great importance, especially with reference to treatment.

It sometimes happens that after the tuberculous matter has been discharged, very intractable ulcers are left behind, and similar ulcers of the integument are often seen, which we reasonably conclude to have resulted from the deposition and discharge of tubercle. They are often preceded by ill-defined deposits in, or indurated patches of, the integuments and subjacent tissue. These, after a while, inflame and soften, and discharge a thin turbid pus. Often the mischief extends more deeply, as in the neighbourhood of joints; but the same course is followed: first, the deposit and the induration; then the liquefaction and inflammation; at length the abscess with its serous and curdy pus; and finally, but too often the indolent and intractable ulcer. These ulcers assume all sorts of shapes, but are almost invariably irregular in outline. The surface is uneven, with large, pale, and flabby granulations; the edges rounded, thickened, and often undermined. There is generally in the less chronic forms some surrounding redness, but it is of a dusky and livid hue. They are usually remarkably passive, torpid, and stationary.

When these abscesses or ulcers heal, generally a very obvious scar results. The cicatrix is dense and thick, and frequently deeply coloured, from passive congestion. Often it is considerably depressed; sometimes the surface is raised into ridges. Its continued contraction often causes considerable puckering of the integuments around.

When tubercle is deposited, in addition to the constitutional treatment to be spoken of presently, what can be done locally?

So long as active symptoms are absent, perhaps the less that is done the better. The great object is, to prevent inflammation; and this is best averted by protecting the tumour from all sources of irritation, and keeping the parts in as quiet a condition as is possible. Frequent handling is particularly mischievous. While it remains passive, any kind of interference is more likely to do harm than good, by exciting active symptoms either in the tumour or in the parts around. Of course, if there be any tendency to absorption, if the tumour should at all diminish, the indication for doing nothing is still stronger. If, after the lapse of some considerable time, weeks or months, the tumour should still remain passive and stationary, it may become proper to employ, cautiously, some means with the view of stimulating absorption. Gentle and uniform pressure, if the situation will admit of it, or some mild stimulating application, such as a weak solution or the ointment of iodine, or oil gently rubbed over the surface with or without the addition of camphor or ammonia,—these and similar applications sometimes appear to be beneficial; but their effect must be closely watched, and discontinued if any symptom of vascular excitement should present itself.

But supposing, as is sometimes the case, that, in spite of these or even still stronger applications, the tumour remain indolent and stationary, should any other measure be adopted? Should it be removed by operation? Hardly ever. Such a case may occur,—cases have occurred in which tuberculous glands have been successfully removed by the knife, but far more frequently the operation has been followed by very uncomfortable results. Enlarged absorbent glands, whether from tubercle or other causes, especially in the neck, are very deceptive. When examined through the integuments, the mass may appear to be well defined, isolated, entirely superficial, and freely movable upon the subjacent parts; but when exposed in an operation, a small portion of it perhaps is found to creep under the sterno-mastoid muscle, or into some deeper portion of the neck. This leads to, and is connected with, another gland, also enlarged and diseased, but which lay too deep for detection before it was exposed. This, of course, must not be left; but the attempt to remove it discovers that it is in the same way connected with several others affected like itself, and so the surgeon finds himself at the commencement of the chain of glands very appropriately called "concatenatæ," and what is worse, in the midst of structures which prudence declines to dissect. So the operation must be completed with this very unpleasant result—a small part of the disease removed, and the greater portion left behind. The operation can be justified only when the tuberculous gland has remained for a very long time stationary in spite of all local measures and constitutional treatment; when from its size or situation it is either seriously inconvenient, or an unsightly deformity; and when, so far as a careful examination can discover, it is not connected with diseased glands more deeply situated.

When tubercle in a gland or elsewhere begins to soften, the object of the surgeon is to conduct it to its issue with the least possible amount of disturbance to the surrounding parts, to keep the inflammation within its specific limit. Water-dressing with warm fomentations are usually most comfortable. Poultices, generally speaking, do not agree very well; but occasionally a light bread-poultice, made according to Abernethy's prescription, proves very grateful. I venture to question the propriety of the usual recommendation to open these abscesses early. The grounds for this practice do not appear to me to be valid ones. So far as I have been able to observe, when the inflammation is not unduly extensive, after suppuration has occurred, and the central portion of the mass has become soft and fluctuating,—and as the integuments over it become thinner, there is generally a sensible diminution of the surrounding disturbance,—the area of inflammation contracts. Moreover, in these cases, just at the period when an ordinary abscess would point and discharge its contents, these often recede, not spreading into the parts around, but apparently by absorption. There is less tension of the integuments. They become relaxed, sometimes appearing slightly shrivelled, and the blush of inflammation is less vivid and extended. I believe that these salutary changes are often prevented by too hasty interference. In these cases, as a rule, the symptoms of suppuration are not of that urgent character which renders an early evacuation desirable. The pain is seldom severe. The constitution is not often disturbed. Of course when the inflammation is disproportionately severe and extensive, the question is entirely different; measures more prompt and active then become necessary. Sometimes the abscess will disappear altogether without opening, but an artificial aperture is generally advisable when a natural one appears inevitable. This should be very moderate in size; extending only through that portion of the integument which appears unlikely to survive. The puncture should not be followed by pressure. It can do no good to force out violently that which will flow out naturally. Unnecessary pain is inflicted, and still more important mischief is often effected, by bruising parts which are not able to resist, but very prone to resent, such an injury. The mischievous effects of pressure may not be, and are not always, obvious; but I believe the balance to be, even then, on the side of evil.

These abscesses too often degenerate into those troublesome and obstinate ulcers previously described. The best local applications are those which are gently stimulant, such as Peruvian balsam, the tincture of benzoin, the red oxide of mercury, a weak solution of nitrate of silver, &c. Sometimes the surface may be touched with nitrate of silver or sulphate of copper with advantage; and when the edges are spongy and livid, it may be proper to destroy them with caustic, or to remove them with the knife.

The question is often raised, whether, supposing we were able to do so, it is desirable, in certain cases, to heal these ulcers. It is believed that they may act as natural outlets for an exudation which might otherwise be deposited in more important parts. The fact is, until the state of the constitution is improved, and the tendency to the deposit counteracted, there is not much chance of healing them; and, when the general health is restored, they will spontaneously close without risk. That they heal, may be generally accepted as a proof that the source of danger is removed.

This question becomes more doubtful when raised with respect to the performance of a capital operation, such, for instance, as the removal of a portion of a limb for what is usually termed scrofulous disease. In such a case the decision must depend on the state of the constitution; the condition of the more important organs, as the lungs; and the effect which the disease, whose removal is contemplated, has upon the system. Have all other means failed? Is the patient able to bear the operation; that is, is there power sufficient to accomplish the process of repair? If there be extensive or active disease in the lungs, the operation can only hasten the catastrophe. Can the disease in the extremity be so conclusively connected with the constitutional symptoms, the hectic fever, as cause and effect, to render it fairly probable that they will subside when that is removed? This question is one of the most difficult that the surgeon is ever called upon to answer. A sound decision in any case can be founded only upon careful and continued observation.*

But in the treatment of deposits of tubercle local means are worthless in comparison with constitutional measures. It can avail but little to encounter the effect alone, while the cause is still in operation. The grand indication is to arrest, if possible, the tendency to the formation of tubercle. The treatment of the deposit is comparatively of little moment.

Amongst drugs, those most esteemed in the treatment of this disease are, iodine and iron, bark, the alkalies and mineral acids, and, above all, cod-liver oil.

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* See elsewhere for the special description of tubercle in the bones and other local deposits.

Before a course of any medicine is commenced, the condition of the digestive apparatus should be carefully scrutinised, and any disorder of it should be, so far as it is practicable, rectified. While those symptoms previously enumerated exist, matters are only made worse by the exhibition of tonics. A disordered state of the digestive organs is most commonly seen in children, and is best treated by strict attention to the diet, and the regular use of some mild aperient for a few days or longer. A few grains of rhubarb and soda for some nights in succession, occasionally combined with a little gray powder, and then followed by a dose of castor-oil the next morning, in order to clear out the canal, usually succeed very well. But it is needless to enter into detail. The principle of treatment is the point to be insisted on. Concerning the method of carrying it out, almost every one has some especial fancy of his own. Assuming, then, this difficulty to be absent or to be overcome, the way is clear for the employment of tonics.

The preparations of iodine are most likely to prove serviceable in the absence of all fever and vascular excitement. If these are present, they often only increase the mischief. They may usually be prescribed with advantage in simple but concentrated decoction of sarsaparilla.

Iron, as might be expected, is sometimes eminently beneficial. Its use is especially indicated when the symptoms of anæmia predominate; when the blood seems poor in red cells; still more if this be combined, as it commonly is, with a feeble circulation and a general want of tone. Among the milder preparations are the ammonio-tartrate and citrate and the potassio-tartrate. The last is especially useful for children, and has the additional advantage of being compatible with the alkalies. The vinum ferri too is a mild and simple preparation, and very often a most valuable one. But the sulphate of iron, when it can be borne, is sometimes much more efficacious, and the tincture of the perchloride is perhaps the most powerful of all. But iron will not suit the system in all cases of mere debility. When the lips and conjunctivæ are florid, it is least likely to agree.

Iron and iodine may be often very profitably prescribed in combination. The syrup of the iodide of iron is a very convenient form.

Bark, and its preparations generally, are particularly useful, during the period of suppuration, in supporting the system and averting hectic fever. It is curious to observe what effect it sometimes exerts upon this process. It tends to bring matters to a crisis. Doubtful symptoms of activity in and around the deposits will often subside; and a slow, languid, imperfect suppuration is often pushed forward into a more healthy action. When the flesh is flabby, when there is great debility, when the appetite is bad and the excretions tolerably healthy, then bark is indicated.

In such a case the mineral acids also are generally given with advantage. They are deemed especially useful in checking the profuse perspiration of hectic fever.

The alkalies and their carbonates are often very useful in the treatment of strumous dyspepsia. They are more particularly indicated when the urine is highly acid, and contains an excess of the lithates, or still more, any free lithic acid. For children, lime-water, either in milk or sarsaparilla, is often serviceable, or the carbonate of magnesia held in solution by excess of carbonic acid.

When there is much local disturbance about a tuberculous deposit; when the inflammation appears to be independent of any change in the mass itself; and more especially if this be combined with any gastric disturbance, the operation of an emetic will often be followed by signal improvement.

Aperients and purgatives are perhaps too often employed in mere routine. During a course of tonic medicine they are generally required from time to time, and always when the state of the tongue and the excretions indicate a loaded condition of the intestinal canal, or the presence of morbid matter, such as imperfectly digested food, or depraved secretions.

But of all medicinal remedies for scrofula none at present enjoys so high and well-founded a reputation as cod-liver oil. The fixed oils, as a class, are often beneficial; and it is curious to note, in connexion with this fact, when considered in its relation to nutrition, that some have observed very often in cases of scrofula a peculiar dislike to fat; but for its efficacy cod-liver oil surpasses every other. Some have sought for the cause of this superiority in the iodine, bromine, phosphorus, and other of its constituents. But the proportion in which these exist is too minute to render it probable that they have any considerable share in such important results; and, moreover, these elements have been used in various other combinations without benefit at all comparable with that which is obtained from the oil. Perhaps its excellence may be more closely connected with its disposition to form an emulsion more readily than other oils, for it is peculiar in saponifying with the carbonates of the alkalies. This may possibly in some measure explain its more ready absorption from the intestinal canal. It has been suggested also that it is more easily digested than other oils, because it contains, to some extent, the principles of the bile.

The beneficial effects of the oil are very general throughout the body. But the most remarkable, although probably by no means the most important, is the increased accumulation of fat. When it first came into general use, people were surprised at the rapidity and extent of its action in this respect. Great difference of opinion still prevails as to the particular kind of cases in which it is most serviceable. It is assuredly more or less so in the vast majority.

But that the best effects may be obtained from its use, it must be taken for a very long time. Want of perseverance here is attended with its usual result—disappointment. It is not a question of days only, but often of months, or even years. It should therefore be regarded as an article of diet rather than as a medicine, and usually, after a while, the dislike to it ceases. A table-spoonful may be considered a full dose for an adult; but this quantity should be gradually arrived at, commencing with a teaspoonful. It may be taken twice or thrice daily, and immediately after a meal; for at that time it is least likely to create nausea, and, moreover, it does not then interfere with the appetite. It may be taken upon a small quantity of some other fluid, such as a little wine or a bitter infusion. When the stomach is weak and there is a tendency to nausea, a solution containing the fortieth or thirtieth of a grain of strychnia, acidulated with nitric acid, often proves a most useful vehicle. This I first learned from Dr. Williams. Some people, and especially children, can take the oil alone without any discomfort. Again, some persons can take it for any length of time with impunity; but in the majority, after a while, it is apt to create nausea, and produce other symptoms called bilious. I think the best way of avoiding this is to suspend its administration for a day or two, now and then, and if necessary, at that time to give an aperient. Of course it is much less likely to disagree when the digestion is good, and it can be taken much more comfortably by those who are able at the same time to use exercise. As might be expected from its composition, it can, as a rule, be taken in larger quantities, and for a longer period, in cold than in warm weather.

Probably the lightest and clearest oil is the best. It has never been shown that the darker oils possess any additional advantage, and they are much less likely to be borne. In cold weather the oil should be slightly warmed before it is taken, for it is thus rendered less tenacious, and is more readily swallowed. These details should not be despised. In almost all cases it is of the utmost importance that the oil should be taken, and by due attention to such details as those just alluded to, this may generally be accomplished.

But, after all, medicines, even cod-liver oil, should be only accessary to hygienics. Sometimes, perhaps often, in the earnest application of some particular remedy in the treatment of disease, we are apt to neglect the adoption of those more general means by which diseases are averted and the health is preserved.

With regard to scrofula, whether tubercle be already formed or not, all the causes previously mentioned should, so far as they can, be avoided. All causes of debility should be carefully shunned, and the system should be raised as nearly as possible to the level of perfect health.

The food should be nutritious and sufficiently abundant, and should contain a fair amount of proteine principles. Stimulants, if needful, should be taken in moderation, never in excess. A mother with scrofula should not suckle her children, for this is prejudicial both to her and them; but a healthy wet-nurse should be obtained: and Sir James Clark recommends that the child should not be weaned until the period of "teething" has passed. The due warmth of the body, not neglecting the extremities, should be secured by adequate clothing, and flannel should always be worn next the skin. Constant residence in pure and dry air, and regular exercise proportioned to the strength should be recommended. If proper exercise cannot be taken daily, friction of the surface with a flesh-brush may be substituted. Tepid or cold bathing is useful, especially in salt-water, if it can be borne and is followed by perfect reaction. The mind should be cheerfully occupied, but not unduly tasked. This last point is especially important in regard to children. Too often, in the natural anxiety to educate, the state of the health is overlooked or forgotten. Unfortunately, the scrofulous diathesis is frequently accompanied by unusual activity of mind, which is apt to be encouraged, but needs to be restrained.

It has been already stated that the climate of Great Britain is not the most congenial for those who possess the scrofulous diathesis. Yet there are some situations free from the most important objections; where the atmospheric changes are less frequent and sudden, and the winter comparatively mild. When the diathesis is more strongly marked, it often becomes necessary, in order to avert its further development, to seek abroad a milder and more equable climate.

But it is surely a mistake to suppose that a warm climate is the one best adapted to all cases of scrofula. It is so doubtless in the great majority in which the disease is far advanced; but in many cases, at an earlier stage, its further development is more satisfactorily arrested and the general health improved by a more bracing air. Children with tuberculous glands, but whose general health appears otherwise tolerably good, would perhaps profit less by transportation to Madeira or Egypt than by residence on the south or west coast of England. Delicacy of constitution is sometimes increased and mischief encouraged by dread of exposure.

Of course, on all these subjects relating to hygienics, there are many matters, other than those with which we are concerned, to be taken into consideration. All depends upon the person's position in life and the circumstances by which he is surrounded. It is often only a choice of difficulties involving more than one vital question.

WILLIAM SCOVELL SAVORY.

HYSTERIA.

HYSTERIA would be much less interesting and important if its phenomena were confined to its occasional paroxysms, and its other characteristic and distinctive symptoms. An hysterical fit seldom presents any difficulty of diagnosis, for its nature is usually sufficiently apparent; and the same statement will prove true, although, perhaps, a little further inquiry will be sometimes needed, for many other of its less striking but not less decisive manifestations, such as the globus hystericus, and other milder forms of the attack. But hysteria does not always assume this regular and characteristic form; on the contrary, it frequently occurs strangely disguised, and its essential features concealed in the garb of some other disease, whose characters it assumes and whose symptoms it mimicks. This it is which especially gives interest and importance to hysteria; which so often renders it a stumbling-block in the way of a correct diagnosis, sometimes masking by its prominent symptoms the existence of a graver malady, but far more frequently by the similarity of its symptoms leading to the opposite error of mistaking a simulated for a real disease. And this form of hysteria has been aptly termed protean; for there are few diseases, the symptoms of which are not at times more or less mimicked by this singular affection.

The hysterical fit in its common forms is not likely to be mistaken. However much it may vary in duration and severity, its general characters are sufficiently obvious and well known, whether it consist merely in a violent and uncontrolled display of emotion or appear fully developed. The deep and hurried inspirations at the commencement, followed by occasional sighs or sobs or screams —the sense of choking, leading to agitated movements of the hands about the neck, as if to remove some oppression there—the irregular muscular movements generally, such as struggling like a person contending, beating the breast, or tearing the hair—the withdrawal, more or less complete, of the power to balance and sustain the body —and with all this, seldom loss of consciousness, although sometimes sensorial disturbance — the flushed, but calm and not distorted, countenance — the closed and perhaps trembling lid, with the eye bright and natural beneath — the hot skin, excited circulation, vehement action of the heart, which, however, subsides as the fit declines—the whole terminating either in violent laughter, with a copious secretion of pale urine, or in tears, or in a combination of the two, or in sleep more or less profound, — these symptoms are not to be misinterpreted. By the consciousness not being wholly lost, especially at the commencement; by the absence of well-marked and decided convulsions, limited to one side or to some portion of the body, the muscular movements being rather struggling and capricious; by the absence of all lividity, particularly of the face, and distortion of the countenance; in a word, by the absence of all signs of impeded respiration, which on the contrary is deep and sighing; and finally, by the subjects of the attack being almost always women at that period of their lives when the uterine functions are active, the hysterical fit is distinguished from every other. The duration of the fit may vary from a few minutes to several hours. Occasionally such paroxysms succeed each other at frequent intervals, the person remaining in the mean while in a drowsy state. In this way the attack may be extended over some days. In its slight and transient forms many of these symptoms do not appear. A very common variety is limited to what is termed the globus hystericus. A sense of uneasiness or discomfort is felt in some portion of the abdomen, usually in one of the iliac regions,—and it is said to occur more frequently in the left,—as of a ball or some solid body. This is described as rolling about, and then rising upward until it reaches the throat, when a sudden and alarming sensation of choking is experienced, but often attended with frequent attempts to swallow. This usually ends in a similar manner to the more fully developed attack.

Although the characters previously enumerated, when fairly developed, are peculiar, and sufficiently distinguish the hysterical from all other fits,—for instance, from epilepsy, both by positive and negative symptoms,—yet it occasionally happens that cases occur presenting features which may almost be said to be intermediate between these for the most part widely-separated affections. Many of the symptoms of hysteria may be united with others which are ominous of epilepsy. This is what might be naturally expected. It is only one instance out of so many in which diseases distinct enough in their typical forms are prone in certain instances to blend with others which trespass on their confines.

Perhaps the principal cause of neglect of the study of hysteria is the generally accepted fact that its attacks are hardly ever of a dangerous character. This, however, requires some qualification. Certainly death, either as a direct or indirect result, is exceedingly rare, although it appears that even this fatal effect has been induced in some instances by exhaustion. But an evil worse than death occasionally waits upon hysteria. It is not difficult to understand that the mind rather than the body may at length succumb to violent and oft-repeated attacks. The mental faculties being thus weakened and disordered, hysteria sometimes leads to insanity.

To enumerate all the diseases which are liable to be simulated by hysteria would be to furnish an almost complete nosological table. "This disease," Sydenham wrote, "is not more remarkable for its frequency than for the numerous forms under which it appears, resembling most of the distempers wherewith mankind are afflicted. For in whatever part of the body it be seated, it immediately produces such symptoms as are peculiar thereto." Leaving out of consideration here those which fall to the lot of the physician, such as peritonitis and paralysis, we may glance at the more prominent ones, the care of which devolves upon the surgeon. These will sufficiently illustrate others.

Disease of the spine. A young woman will complain of pain in the back, with weakness of, and perhaps pain in, the lower extremities. Often there is a sense of constriction in some portion of the trunk, with occasional spasms. There may be even paralysis, accompanied with a difficulty of voiding the urine. When the spine is examined, it will be found to be acutely tender. A more careful examination, however, will probably discover that the pain is not confined to one portion of the spine, but extends to different regions, and is inclined to vary in position. Moreover, the tenderness is excessive and superficial, so that the patient flinches and complains more when the skin is pinched than when the vertebræ are pressed. And it should be borne in mind that most persons, more especially women and children, will start or shrink when sudden, although comparatively slight, pressure is made for the first time in the lumbar region of the spine; and this flinching, as Skey points out, is much more considerable if at the time of the examination the body be unsupported in front. Then, although the disease may have existed some time, there is no corresponding constitutional disturbance. The normal condition of the body is maintained. There is no wasting; no defect of nutrition. All this occurring in a young woman, in whom probably the circulation is weak, with some disorder of the uterine or other functions, stamps the disease as hysterical.

Disease of the joints. A girl will complain of severe pain and tenderness in the knee. The joint is fixed and immovable, and any attempt to move it elicits loud cries. But the tenderness, as in the last case, is excessive and superficial, so that she complains more when the skin is touched than when the heel is pressed upwards. There is frequently, too, a tendency to spasm; but this is different from the painful and involuntary startings of the limb at night in the real disease. Often also the leg is fixed in the extended position, whereas in real disease of the joint it is usually bent. However, to this rule there are abundant exceptions. The joint does not undergo any material alteration in size and shape, although there is often some degree of fulness—a puffy swelling. In some cases the enlargement may be considerable; but when this occurs, it is due to some local applications which have been previously employed. The joint, and indeed the whole limb, is very subject to frequent variations of temperature. "Thus, in the morning the limb may be cold, and of a pale or purple colour, as if there were scarcely any circulation of blood in it; while towards the afternoon it becomes warm, and in the evening is actually hot to the touch, with the vessels turgid and the skin shining." Moreover, there is always a sense of weakness in the limb, which, after a while, is partially due to the condition of the muscles consequent on their inaction. Then there is the absence of constitutional symptoms. Although the sleep may be disturbed, and the patient watchful, there is not that almost entire absence of it which is so serious a feature in destructive disease of the joint. There is here a sufficient proportion of sleep for the necessities of the system. All this having existed without any material alteration for some time, with perhaps evidence of general debility or some local disturbance, proves the affection to be hysterical.

Or the hip-joint may be affected. There is pain in the hip and knee, aggravated by pressure and motion, and the patient lies fixed in one position. But here again the pain is diffused and superficial. Then time effects no real alteration in the condition of the limb. The investing muscles do not waste. There is no flattening of the nates. There may be unusual fulness about the joint, leading for a time to a suspicion of abscess. Sir B. Brodie observes that it is not uncommon to find much alteration in the figure of the parts. The pelvis may project posteriorly at the same time that it is elevated towards the affected side, so as to make an acute angle with the column of the vertebræ. Under these circumstances the limb is apparently shortened, so that when the patient stands erect, the heel does not touch the ground. This strange distortion, due to the predominant action of certain muscles, assisted by the long-continued unnatural position, must not be confounded with dislocation. These affections of the joints sometimes terminate in remarkably sudden recovery.

Disease of the mammary gland. The breast of a young woman is very painful and tender, and there is probably an unnatural fulness and tension of the entire gland, obvious when contrasted with the opposite one. The skin may have a glossy aspect, but the surface is very pale; or perhaps here and there ill-defined portions of the gland appear somewhat more indurated than the rest. These symptoms, especially the last mentioned, are very much aggravated by repeated handling, to which, unfortunately in these cases, the breast is continually subjected, so that often the suspicion of some tumour is excited, by which matters are made infinitely worse, inasmuch as it leads to repeated and prolonged examination. In these cases the true diagnosis is usually confirmed by the condition and history of the patient. There is commonly clear evidence of a feeble circulation and general debility, very frequently associated with some irregularity or other disorder of the uterine functions. Often too there have been previously some decided symptoms of hysteria.

Retention of urine. A patient declares that she is unable to void her urine; that she has no power over her bladder. The bladder may be distended even to an abnormal extent, and yet the urine is retained. The absence of all local causes; the healthy condition of the urine; and the character and history of the patient, generally remove all doubt of the nature of the case. If the bladder be artificially relieved, the evil may be indefinitely prolonged. On the other hand, continued retention may lead to chronic inflammation or paralysis. These untoward results are, however, comparatively very rare. The patient, if left to her own resources, usually discovers before very long that the power has returned.

Local pain. Pains of every kind and degree of severity affecting any and, in succession, every part of the body are common enough in hysteria. One of the most frequent and familiarly recognised has been called *clavus hystericus.* This is a pain in some one point of the head, which has been likened to the supposed effect of driving a nail into the part; hence the name. Its usual seat is immediately above one eyebrow. It is frequently more or less intermittent, and sometimes when the paroxysms occur at regular intervals, it closely imitates the affection called brow-ague. Another very common seat of pain is the side below the mamma, usually the left. It is generally accompanied with acute tenderness, so that the person is unable to lie upon it. It is sometimes described as a stitch in the side. It is often remarkably persistent. The character of the patient and her history generally declare the nature of the case. These and various other pains, more especially those in the head, are commonly described as amounting to excessive agony, and the subjects of them are very seldom at any loss in their description. Their imagination usually furnishes abundant similes and illustrations. It is not uncommon after a time to perceive in the part complained of a full and puffy condition of the integuments, accompanied with increased heat and perhaps some trifling vascularity. This immediately leads to the suspicion of abscess, and that after all the diagnosis was wrong. In truth, many of these cases are for a while exceedingly perplexing, and sometimes it is impossible to establish at once a clear and satisfactory diagnosis. Chronic abscesses are often very insidious in their progress and, at their commencement especially, most obscure. On the other hand, these local hysterical affections sometimes occur in those in whom they would be least expected to arise ; in whom, perhaps, no other evidence of hysteria is, for the time, apparent. The diagnosis of these pains is sometimes still further complicated by the fact that they may have supervened upon some injury, which perhaps was trivial, but which may be described as severe.

But instead of being thus unduly exalted, the natural sensibility of a part may be variously perverted or completely lost. And these disorders are not limited to ordinary sensation, but affect the special senses also.

Inequality and local variation in temperature are not uncommon.

And the same remark may be extended to the affections of voluntary motion. Every variety occurs, from violent convulsion or spasmodic contraction of a limb or muscle to complete paralysis. And often two or even more of these disorders co-exist, so that it is easier to imagine than to describe the innumerable forms and varieties of local hysterical affections.

It may be well to review for a moment the chief points which should be borne in mind in the diagnosis of hysterical affections.

In the first place, the subject is generally a young woman, in whom, perhaps, the functions of the uterus or of some other organ have been for some time and are disordered, and in whom hysteria may have been already manifested in some of its more regular forms. Yet it would be a grave error to suppose that local hysterical affections do not occur in subjects who present none of these conditions. They are incidental to women even in advanced periods of life, and in whom no error of function can be elsewhere discovered.

Nay, they are sometimes witnessed in the opposite sex, and I venture to think more frequently than is commonly imagined. Young men, the subjects of excessive mental or bodily fatigue and prostration, not unfrequently exhibit local affections which cannot in any way be distinguished pathologically from those which are called hysterical. Every form of disease and infirmity is, in turn, supposed to exist, and abundant evidence is furnished of the accuracy of Aristotle's observation, that melancholy persons are most ingenious. Such cases are often termed hypochondriacal; but when hypochondriasis is employed in this sense, it appears to me to become synonymous with hysteria. Indeed, Sydenham and others have considered hypochondriasis as a modification only of hysteria, the difference depending merely upon sex. Certainly they are connected by all their main features, and it is more than difficult to say in what essential points they differ. Nor are local hysterical affections always preceded by hysterical paroxysms. To assume this would be as grave an error as to suppose that these local forms are always cases of voluntary deception. No doubt, in the majority of cases, careful inquiry and examination will elicit some other evidence of hysteria either past or present. But to this rule there are many exceptions, and the surgeon who relied upon it in his diagnosis would be led too often seriously astray.

Then, although the affection may have existed—and it usually will last—for a considerable time, there is no commensurate impairment of the general health and strength, such as is produced by organic disease. The contrast between the local symptoms and the general mischief always furnishes most important evidence.

A careful cross-examination of the local symptoms will generally elicit some contradiction or inconsistency. For instance: the pain and other symptoms are often remittent or intermittent, not steady and abiding. The pain is often superficial; in fact, integumental, and very prone to be widely diffused beyond the supposed seat of mischief. Moreover, although after a time there may be some slight alteration in the size and shape of the part, there is never that decided and peculiar change which is, sooner or later, the inevitable result of certain local diseases.

Chloroform is often of invaluable assistance in the diagnosis of hysterical affections; for instance, in a case of contraction of a limb. When the patient is fairly under its influence, she can neither complain nor resist; and the ease with which the limb can be then extended, its perfect mobility and natural condition, proves the affection to be simply a fault of volition.

But the difficulty of diagnosis is incalculably increased when hysteria supervenes upon some real disease. Ordinary symptoms then become exaggerated, and the cause of their origin is apt to be overlooked in their obvious association with hysteria. Close and continued observation will at length resolve the doubt. In some of these cases chloroform will remove the difficulty. But such a combination is comparatively rare. Hysteria generally disappears before real disease.

Finally, hysteria is far more frequently mistaken for real disease than real disease for hysteria, not only because it appears so curiously disguised and is so prone to simulate other diseases, but also because it so commonly occurs.

Sydenham affirmed that hysterical disorders "constitute one moiety of chronic distempers;" and this statement is endorsed by Conolly. Brodie says, "I do not hesitate to declare that among the higher classes of society, at least four-fifths of the female patients, who are commonly supposed to labour under diseases of the joints, labour under hysteria, and nothing else."

So variable in aspect, so inconsistent in character, hysteria mocks all attempts to define it, and seems to defy every endeavour to explain its pathology. Yet thus much appears clear and certain, —it is essentially an affection of the nervous system.

It is well known that the common office of the nerve-centres is that of variously disposing of the several impressions that reach them through their afferent nerve-fibres. Thus, if communicated to motor fibres, reflex movements are produced; and the reflection may be confined to a single nerve, or it may radiate amongst several. In the one case, the result may be the contraction of a single muscle; in the other, the whole body may be agitated.

Or an impression conveyed to a certain portion of a nerve-centre may be transferred to other parts. Thus what have been called sympathetic pains arise. For examples: pain in the knee in disease of the hip; pain in the shoulder in affections of the liver. But, like reflection, this transference may be limited or diffused. In the latter case a local irritation may produce widely extended effects. A familiar example is presented in toothache; the pain sometimes spreads over both jaws and the face.

On the other hand, impressions producing like results may be transmitted from the brain to the other nerve-centres.

As the rule, in health, the effect produced varies:

1st. As the intensity of the impression. This is commonly obvious, and it is strikingly illustrated in the ganglia of the sympathetic. For instance, the ordinary stimulus of food in the intestines conveyed to the ganglia is simply reflected and produces contraction of the canal. But if, from the character of the food or otherwise, the stimulus be increased, the stronger impression is conducted from the nearer to the more distant ganglia, and more widely-diffused and vigorous contractions result. Or the irritation being yet greater, the impression may reach the cerebro-spinal centres, and radiating thence, produce various pains and contractions, such as cramp.

2d. According to the condition of the nerve-centres. Thus the same impression will produce very different effects in different persons. Irrespective of the power of endurance, one person feels pain more acutely than another, and even in the same person the susceptibility varies at different periods of life. This is shown by the comparative facility with which convulsions are excited in children. An amount of irritation which in the adult would fail to produce any visible effect, will often in the very young, in this way, prove fatal. A familiar example is seen in the effects of "teething."

If, then, from any cause the irritability—that is, the susceptibility to impressions—of the nerve-centres be in any way affected, it follows that the effect of any impression conveyed to them will vary proportionately. So, according to the condition of the nerve-centres, the effect of any impression may be exalted or diminished, or otherwise perverted. This, it may be reasonably assumed, is the key to the interpretation of the pathology of many affections of the nervous system, and amongst them of hysteria.

The particular form which the morbid action will acquire depends, doubtless, upon the seat and nature of the change. No wonder that this change is generally too subtle for our scrutiny, seeing that it may be due simply to the quantity or quality of the blood in the part or to the rapidity of its circulation.

Nothing is positively known of the exact condition of the nerve-centres which predisposes to the production of hysteria. It may be sometimes due to a defect in their original construction, but probably they are far more frequently enfeebled subsequently. It is, almost as a rule, associated with some form of debility of the system, or defect in the general health; and this, connected with its variable manifestations; its sudden access and disappearance, often as the result of some forcible impression on the nervous system; its cure by means which improve the health and strength; and the absence of any discoverable lesion or defect after death, dissection affording only negative evidence,—seem to connect the affection with the quantity and quality of the blood supplied to the nerve-centres, in a word, to their nutrition. That a defective condition of the blood or its circulation should be primarily manifested in these organs, is the result of the fact that no other organs are so immediately dependent on a healthy supply.

The nerve-centres being thus predisposed, a very trivial impression will be sufficient to excite the local or general phenomena of hysteria. The exciting cause may be either some abnormal state of any organ producing irritation, or the disease may have its origin in a nerve-centre. In this way the emotions may be supposed to act.

Thus the exciting cause of hysteria may be either of centric or eccentric origin. In the latter case there may be, as in epilepsy, an *aura hysterica.*

Brodie relates the following cases:

"An unmarried lady, thirty-two years of age, consulted me on account of her being liable to some very distressing paroxysms, in which she experienced a difficulty of respiration, attended with a sense of constriction of the chest, and great general excitement and agitation. These paroxysms often continued for ten or fifteen minutes, recurring at irregular intervals; sometimes without any evident cause; while at other times they might be traced to some sudden emotion of the mind. So far the case did not differ from many other cases of hysteria; but the peculiarity of it, and the circumstance which led to my being consulted, was as follows: There was a particular spot near the ensiform cartilage, which she believed to be in some way or another connected with her complaint. Nothing could be discovered in this part different from what is usual, by the most strict examination; but the pressure of the finger on it never failed to induce one of the paroxysms which I have just described. When these paroxysms were most severe, they were always attended with an abundant flow of limpid urine. These symptoms had existed in a greater or less degree for ten or twelve years, and had supervened on a state of exhaustion occasioned by an attack of typhus fever.

"A young married lady, who was liable to ordinary attacks of hysteria, complained of a tender spot on the anterior part of the abdomen, a little below the ensiform cartilage. The slightest pressure of the finger on it caused excessive pain, and was followed by violent agitation of the whole person, bearing a more near resemblance to the convulsive motions of chorea than to any thing else, and continuing for several minutes."

Viewing hysteria in this light, it is easy to understand its common association with disorders of the uterine functions; an association so frequent, that by many it has been, and is still believed to be, constant, as the derivation of the word implies. That the exciting cause should be so frequently connected with the generative organs is what would be naturally expected from a consideration of the nature of their relation to other organs through the nervous system,—their extensive "sympathies;" their powerful and active sources of excitement, and the numerous disturbances to which they are subjected. But there is ample evidence to show that the exciting cause may be elsewhere, as for instance in the intestinal canal, and act quite independently of the generative organs.

For the same reason it can be understood why hysteria so commonly occurs in women, seeing that the organs of generation, from their nature and influence, are so liable to prove an exciting cause, and that the system generally of women is, as the rule, so much more impressible than that of men.

But, as would be expected in this view of it, hysteria does sometimes, though comparatively seldom, occur in men; although in them the general symptoms of hysteria rarely become paroxysmal. They usually assume the features of hypochondriasis, which, if not identical with hysteria, is yet so closely allied to it, that the one passes by insensible degrees into the other.

Nor is it difficult to understand how hysteria may supervene upon some local disease which may act as its exciting cause. On the other hand, but more rarely and obscurely, a local hysterical affection may lay the foundation of organic disease.

The influence of the mind upon the body is a subject well worthy of the most attentive consideration. If every one were familiar with the striking effects which may be produced by a steady and continued concentration of the attention upon a part of the body, we should hear less of the frauds and follies attributed to "animal magnetism" and of some other deceptions. Hysteria remarkably illustrates the powerful influence of emotions upon both body and mind; and more especially when it occurs, as it sometimes does, in imitation as it were of a paroxysm witnessed in another. It has been often remarked that one hysterical patient in a ward will sometimes produce many more.

It is worthy of note, that in hysteria, more especially in its local forms, the effect produced, leading at length to some change or disturbance in the part, may react upon the susceptible nerve-centres, and thus aggravate materially the existing mischief. It is said that the liability to the hysteric paroxysm bears an exact ratio to its past frequency.

It is sometimes very difficult, if not impossible, to diagnose between hysterical and neuralgic affections on the one hand, and hysterical and feigned diseases on the other. And although in its typical and more common forms hysteria is sufficiently distinct from either neuralgia or voluntary simulation of disease, yet extreme cases are met with by which it appears to merge into one or the other. As a distinctive character between hysteria and neuralgia, it may be said that in the latter the cause of the mischief is always somewhere in the nerve or nerves between the seat of pain and the centre inclusive. Although contrary to the opinion of some, I venture to think that cases of voluntary deception should be separated from hysteria. In practice this may not be always possible, but pathologically the distinction appears to be clear; and to include them under a common term can lead only to confusion.

The management of a person in a fit of hysteria is a very simple matter. Beyond placing her out of the way of mischief on a bed or a couch, perhaps the less that is done the better. Many of the plans of treatment which have been recommended are certainly injurious. It is doubtful if any of them are beneficial. Above all, no restraint should be imposed upon the patient, excepting such as appears to be absolutely necessary for her safety. It seldom happens that she seriously injures herself. Of this there is much less real than apparent danger. The subsequent exhaustion is generally very trifling; there is apparently a curious disproportion between this and the violence of the paroxysm.

In the treatment of hysteria, besides those general measures which are calculated to correct the morbid disposition of the system, special remedies are usually needed to remove the exciting cause. This, in a cursory inquiry, is very likely to be overlooked, as it is often subtle and obscure. It is especially liable to escape notice because commonly connected with some disorder of those functions which, being in more immediate relation with the ganglia of the sympathetic system, are frequently not revealed by direct and obvious symptoms. Yet it is always very important, and often essential, that the exciting cause be detected, and this a close and careful investigation will usually disclose. Then, beyond regarding the condition of the system generally, the state of every function should be particularly examined, more especially those of the uterus, the disorders of which prove to be so frequently the immediate exciting cause; and whatever is discovered to be wrong, either here or elsewhere, must be treated accordingly.

In investigating the nature of any local affection, with the view of determining its relation to hysteria, the condition of the part affected should be carefully examined in the first place,—and this, if necessary, with the aid of chloroform,—in order to discover if there exist any equivalent cause for the evil complained of. Failing in this, the investigation should be carried along the course of its nerves to their centre; and no evidence being obtained of any thing unnatural, the state of all the organs should be successively examined. Then the condition of the system generally in regard to the health and strength, not of the body alone, but of the mind also. And lastly, the previous history and present habits of the patient.

Certain applications are often beneficial in temporarily relieving local pain, such as lotions or ointments of aconite, belladonna, or opium. But there is one grand objection to all of them. They become the means of continually directing attention to the part and of magnifying the importance of its symptoms. The temporary relief of pain frequently fails to counterbalance these evil effects. This objection, however, does not apply so forcibly to the application of plasters; and it is often an excellent plan to cover completely the part with some plaster spread on leather or moleskin, and not to allow it to be exposed or touched so long as the plaster will adhere. Thus the great evil of repeated examination is prevented. In hysterical affections of the breast, for instance, this kind of local treatment is eminently serviceable.

In the case of muscular rigidity or contraction,—as, for example, when the leg is drawn up towards the thigh,—when with the aid of chloroform relaxation has been effected, and the part has been restored to its usual position, it sometimes proves useful to retain it so by means of a splint or otherwise, so that when the patient recovers we are able to appeal to the fact as an unanswerable confirmation of the truth of our conviction respecting the nature of the case. If this plan be not adopted, it is curious to witness the gradual return of the part to its previous condition so soon as the effects of chloroform begin to subside. And even after the artificial restraint has been continued for several days, as a rule, the same relapse immediately follows its removal.

But these obstinate and enduring local affections can be satisfactorily treated only by general measures. The difficulty of effecting a cure sometimes appears to be almost insuperable; and this not so much from failure of the means employed, as from the extreme difficulty in many cases of enforcing their application. And this difficulty is complicated when the exciting cause has its origin in centric disturbances, as mental emotions. For in this case it is too often placed beyond our control. Nevertheless, this we must endeavour to reach if possible; but failing, the attempt should be made to direct the discharge or expenditure of emotion through another and more natural channel; as, for example, in active exercise. This is more practicable than attempting in the first instance to suppress its effects, for in a mind unaccustomed to discipline this is not easily accomplished. The worst fits are those which supervene upon intense efforts to suppress strong emotions. Carter says, "it may be taken as an invariable rule, that the paroxysm will be violent in exact proportion to the length of time during which the feelings giving rise to it have been concealed." As previously stated, when the affection is voluntary on the part of the patient, when it is a case of wilful simulation, then it passes beyond hysteria. But there are some cases—and these are the most perplexing—in which, from long-continued disuse and want of effort, the will has lost its due control over the emotional influences. The most common cases are "those in which the occurrence of the fit, although not volitional, is yet a matter of surrender, and might be prevented under the pressure of an adequate motive."

Besides the adoption of all those hygienic measures which are adapted to improve health and increase strength,—and it must not be forgotten that debility diminishes resistance to emotional as well as to other influences,—a vigorous and persevering attempt must be made to erase all vicious habits and to remove all baneful influences. In order to succeed, the surgeon will need the aid of those whose consistent co-operation it is often most difficult to secure. Friends frequently fail to perceive the necessity of a plan of treatment which otherwise appears to be harsh and cruel. Matters are very often made worse by yielding to that desire for sympathy which is so urgent and universal.

As the rule, hysteria will be found to be engrafted upon some form of debility, and this, in many cases, is the result of the kind of life which these patients have led. Hysteria is one of the many penalties imposed upon idleness. It will be too often found upon inquiry, that while the functions of neither the mind nor the body are ever exerted or even fairly exercised, the emotions uncontrolled are continually subjected to unwholesome excitement.

WILLIAM SCOVELL SAVORY.

SYPHILIS.

CHAPTER I.

INTRODUCTORY. SYPHILITIC INOCULATION. SYPHILISATION.

A REVIEW of the labours of some of the most eminent writers on venereal diseases forms an appropriate introduction to a treatise on Syphilis. The want of any thing like uniformity in the opinions of men who have devoted a great part of their lives to the study of these affections, shows that a clear and comprehensive system, in the truth of which all real observers may agree, has hitherto been wanting. The variety of views which have been maintained, the lengthened discussions which have taken place, and even the varied results of the experiments which have been recorded, all tend to show that the simplicity and unity so characteristic of truth have not been attained by those who, up to the middle of the present century, have laboured in this field of inquiry.

To M. Ricord is due the credit of having introduced a new method of investigating the nature of the venereal diseases, namely, that of inoculating the products of the different affections which arise, with the point of a lancet, on some apparently healthy part of the skin of the affected person.

By this method of investigation, M. Ricord arrives at the following conclusions, which are adopted by MM. Maisonneuve and Montanier, and others of the same school.

1. That blennorrhagia (or gonorrhœa) and chancre are two affections entirely distinct.

2. That blennorrhagia is an inflammatory contagious affection.

3. That a chancre always produces a specific virus.

4. That blennorrhagia never gives rise to constitutional syphilis.

5. That a chancre always produces a constitutional disease when it becomes indurated.

6. That a non-indurated chancre is always a local disease, and is never accompanied or followed by secondary affections.

7. That a chancre is the only origin of syphilis.*

8. That pus derived from a primary affection is the only contagious element in the disease.* It may be secreted by the skin,

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* In the following pages we shall find ample reason to withhold our assent to the conclusions contained in the seventh, eighth, and ninth propo-

by a lymphatic vessel or gland, and the ulcer which supplies it may be simple, indurated, or phagedænic.

9. That no secondary or tertiary disease is capable of being communicated by contagion.*

10. That blennorrhagia may arise spontaneously, and never produces any disease but blennorrhagia.

These conclusions are the result of experiments said to have been repeated a thousand times, under a great variety of circumstances. In the experiments made by M. Ricord, he found that simple blennorrhagia never gave rise to a chancre, and he therefore concludes that this disease is not syphilitic. If the discharge, however, arises from a concealed chancre in the urethra, then inoculation may produce a chancre; this affection M. Ricord considers syphilitic. He believes the pus from a chancre to be always capable of being inoculated when taken during its period of progress, or during the time that it remains stationary, but not when taken during the period of its reparation; it has then become a harmless ulcer. The pus from a bubo he likewise regards as inoculable when taken from the gland itself, but not when derived from the surrounding cellular tissue.

By this method of investigation M. Ricord has endeavoured to draw a clear and well-marked distinction between those diseases which are syphilitic in their origin, and those which are not. As general conclusions from all his experiments, he deduces—

That a primary venereal sore which has healed, or still remains open, does not prevent other similar sores from forming; and that there appears to be no definite limit to the number of successive inoculations which may take place.

That a person actually infected with a primary disease in one part is never subject to the occurrence of similar affections elsewhere, unless the disease be conveyed by the contact of the matter from the primary sore, or be communicated in like manner from some other person.

That secondary disease, depending upon a general infection of the system, will never prevent a person from contracting fresh primary sores.

That the frequency with which constitutional symptoms manifest themselves is by no means in proportion to the number of primary sores developed at the same time.

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sitions, inasmuch as it will be distinctly shown that the secretion of certain forms of secondary syphilis is capable of producing syphilitic disease in other persons.

The concurrent testimony of all observers has now ceded to M. Ricord his first point; namely, that the pus derived from a chancre contains a very powerful agent which escapes detection by our senses, and which is not found in the pus of blennorrhagia; when this subtle and occult agent is inoculated, the morbid process which ensues may be traced in the most satisfactory manner. If the pus from a suppurating chancre, during its period of progress or during the time that it remains stationary, be inoculated, the following succession of events may (according to M. Ricord) be observed:

During the first twenty-four hours some redness appears at the spot where the inoculation has been made. From the second to the third day there is some swelling, affording the appearance of a pimple, surrounded by a red areola. From the third to the fourth day, the cuticle is raised by a turbid fluid, which often forms a vesicle, with a little dark spot in its centre. This spot results from a small effusion of blood at the time of the inoculation. About the fourth or fifth day the secretion becomes increased in quantity, and more or less purulent in appearance. The centre of the pustule now becomes more depressed, in this respect resembling the pustules of smallpox; at the same time, the surrounding redness may become fainter. From the fifth day, the subjacent tissue, which had before undergone no change beyond being slightly œdematous, becomes infiltrated by a plastic lymph, which affords to the touch the peculiar hard and elastic feeling of certain forms of cartilage.* After the sixth day, the pus becomes thicker, the cuticle over it gives way, and scabs form on the surface of the part. When these scabs are detached, a chancre presents itself.

M. Vidal, one of the latest writers on the opposite side, is of opinion that certain persons are naturally incapable of being inoculated with the syphilitic virus; and that in others this immunity may be acquired under certain circumstances. As an instance of the first kind, he cites the case of a man well known to many of those who had taken part in the discussion on syphilisation in the Academy of Paris. This person had never been affected with syphilis, although he had continually exposed himself to contagion. He was, moreover, twice inoculated with pus taken from a chancre during its active stage, with no result whatever. It may be said that this natural immunity supposed to be enjoyed by certain persons from the effects of inoculation, does not invalidate this means of ascertaining the real nature of venereal sores, inasmuch as in *their* case the very same conditions would render this test unnecessary.

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* It does not appear how M. Ricord became acquainted with this fact. According to his own published opinion, the process of induration could only take place in those who had not previously had constitutional syphilis; and these M. Ricord has always with great propriety refused to inoculate.

"But," says M. Vidal, "this disposition may be acquired;" and he instances the case of M. Laval, who, after having been repeatedly inoculated on the upper extremities, at length became proof against any further inoculation. "I am perfectly certain," he says, "that M. Laval was inoculated upon three occasions by M. Gosselin (with pus which produced chancres upon another patient) without effect." This same M. Laval, however, was at length successfully inoculated by M. Ricord. This is explained by M. Vidal, upon the supposition that after a certain number of inoculations, the system loses its susceptibility to the effects of the syphilitic virus for a time, but that after an interval of rest it may again, as before, become subject to the disease.

With this explanation, M. Ricord and his school appear little satisfied. "Give me," says he, "a person who has been syphilised, and who is proof against further infection, who will come before the class at the Hôpital du Midi or before the Académie; who will enter the lists with me, and defy me with the arms of my choice." This challenge was published on the 12th August; on the 22d M. Auzias accepts it; on the 23d Sept. M. Ricord declares himself ready; on the 4th Nov. he announces that the experiments have commenced, and that the results will be published in the *Union Médicale.*

"Search the records," cries M. Malgaigne, before the Académie de Médecine; "the promised communication has never arrived." A week afterwards, M. Ricord presents M. Laval to the Chirurgical Society, and on the 18th November to the Academy of Medicine. Not a word is said about the above-mentioned experiments. On the 9th December, M. Marchal writes to the *Gazette des Hôpitaux*, that M. Laval has presented himself to M. Ricord, who had twice made seven inoculations with three different kinds of pus, each of acknowledged efficacy, without producing any result. M. Ricord answers nothing, and the *Union Médicale* is silent.

M. Malgaigne continues: "This silence appears to me very like a defeat. I should, however, have preferred an open and public avowal of the result of the experiments, and therefore I urged some explanation on the point. Several presented themselves. But what did M. Ricord himself say? That he had produced upon M. Laval an ecthymatous pustule, sufficiently characteristic not to require further proof; and that the other inoculations which had failed had been done with pus, which had also failed to produce its specific effects when inoculated on the patients from whom it was taken."

No further details of these experiments are given. M. Ricord declares that his dignity would be hurt if he gave any further explanation. "That does not satisfy me," says M. Malgaigne. "What connexion is there between M. Ricord's dignity and the details of an experiment? By his own avowal, upon his own ground, having entered the lists with the 'arms of his choice,' M. Ricord succeeded only once in seven times. But the inoculations failed upon other patients, which proved that the matter was not good! Who would have thought that M. Ricord, after so solemn a challenge, in his immense practice, and with his choice of arms, should not have been able to find some good pus?

"But at length one inoculation succeeded. Granted; provided that the counter experiment, which M. Ricord himself declares always indispensable, was made, viz. that the pus produced by the inoculation could be again inoculated.

"For my part," concludes M. Malgaigne, "I regard the fact that certain persons may acquire an immunity against syphilitic inoculation as incontestably demonstrated. If M. Ricord doubts it, I will engage to produce a young man who believes himself syphilised, and who will defy M. Ricord to produce in him a single atom of pus capable of being again inoculated. M. Ricord shall take his precautions. If he does not succeed, he shall begin again; my patient declares himself ready to allow twelve hundred inoculations to be made upon him; and more if these should not be deemed sufficient."

Leaving these chivalrous opponents, we come to the consideration of M. Ricord's proposition, "that a chancre is the only origin of syphilis." A very broad line of distinction is here drawn by M. Ricord and his followers between a primary chancre and every other form of venereal affection. Primary syphilis is alone, it is said, capable of being inoculated; secondary affections never. Persons may be exposed to the contagion of mucous tubercles, to secondary ulcerations, to all sorts of syphilitic eruptions, and will never become infected. The pus produced from these sources will never produce the characteristic pustule of syphilitic inoculation. In cases where apparent exceptions have occurred, either the mucous tubercles have become transformed into real chancres by fresh contact with matter from a primary ulceration, or else real primary sores have been mistaken for some form of secondary affection.

"Secondary syphilis is not contagious. Reason would therefore lead us, *a priori*, to infer that it is not capable of being inoculated, and experience confirms this view."*

On the other hand, M. Vidal, Dr. Waller of Prague, and others, maintain, that mucous tubercles and secondary symptoms may, under certain circumstances, be communicated from one individual to another. They dwell particularly on the undeniable fact that a child may be infected in its mother's womb. They consider it well established that a woman who has neither a chancre nor a syphilitic bubo, but whose constitution is affected, may affect her offspring; that she may bring into the world syphilitic children, who will infect their nurses, who will again, in their turn, transmit the disease to their families.

"Further," says M. Vidal, "that mucous tubercles may be transmitted is generally acknowledged. On this point, MM. Lagneau, Baumes, Cazenave, Gibert, and all observers whose judgment is not warped, may be consulted."

M. Ricord maintains that the origin of the mucous tubercles (said by these gentlemen to have been transmitted) has not been seen, and that the evidence afforded by the neighbouring glands has not been taken into account. A specific ulcer may at first have been the real disease, and have become subsequently transformed into a mucous tubercle; and he believes that all syphilitic disease said to be communicated by contact with table utensils, pipes, razors, masks, &c., have no other origin than the pus derived from a primary sore.† With regard to the transmission of the disease from mother to child and from the child to the nurse, M. Ricord notices what he conceives to be the poverty of the evidence which we have upon the subject.

"I have seen," he says, "nurses and the children they were suckling diseased, and both parties accused of infecting the other. Generally I have been able to trace the origin of the disease to a primary sore on one of the parties. When this has not been the case, I was called too late; five or six months, perhaps, after the child had been with its nurse.

"I have for many years had a number of nurses at the Hôpital du Midi, and I have often given them children to suckle who were sent to me from the Maternité, with secondary affections. Never, as far as my observation extended, were these nurses infected.

"On the other hand, nurses clearly affected with secondary disease have been able to suckle infants which were sent as being affected with syphilis (but who only had had some simple eruptions of eczema, impetigo, or porrigo), and never were these children, whilst under my inspection, infected."

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* Maisonneuve and Montanier.

† *Lettres sur la Syphilis.*

Thus M. Ricord and his followers, while they admit that a child may be affected independently of inoculation *in utero*, believe that after the child is born, it can only be infected by contracting a primary ulcer; and that this may happen by some of the virus being carried by the fingers of the nurse, either directly to the child, or first to the nurse's breast, where a chancre is formed, and that from this the child is inoculated. But M. Vidal maintains that mucous tubercles and some forms of secondary affections may be transmitted quite independent of the mode of inoculation which we have hitherto considered. He draws a distinction between contagion in itself and particular means of contagion, and believes that syphilis may be communicated even when it cannot be inoculated, so as to produce the "characteristic pustule." Even this test he expresses himself willing to offer for the "satisfaction of the schools," and distinctly affirms that he has succeeded in inoculating the secondary ecthymatous pustule.

M. Vidal further believes that certain non-syphilitic affections, which at present are considered incapable of being further inoculated, might ultimately be found to be so, if the proper moment, when they contained inoculable matter, were taken for the experiment. "In the attempts," he says, "which have hitherto been made to inoculate cancer, the ichorous discharge on the surface of the ulcers has been taken, or else the débris of the cancerous matter. But are these the products with which the experiments should be tried? Ought they not rather to have been performed with the cancer-cell in the early stage of its development? In an experiment performed in this manner by Langenback, where fresh cells, from a cancer still warm, were introduced into the blood-vessels of a dog, cancerous tubercles were formed in the animal's lungs."

From these and similar facts, M. Vidal argues that inoculation which fails in one way may succeed in another. The mode of application may have a very material influence upon the result. He instances the fact, that the ordinary mode of inoculating syphilitic matter upon animals is not sufficient; and that M. Auzias Turenne found that he succeeded better by removing the cuticle by means of a pair of curved scissors, and keeping the morbid matter for a minute in contact with the excoriated surface, whilst the surrounding part was gently rubbed. In accordance with these views, he maintains, that although the secretion from a mucous tubercle is incapable of being inoculated in the same way as the pus from a chancre, yet that it is nevertheless capable of producing both primary and secondary venereal affections. That if, for instance, a blister be applied to a portion of the skin, and the excoriated skin be then dressed with lint soaked in the secretion of a mucous tubercle, the inoculation will succeed, although this same secretion may not be capable of being inoculated by a simple puncture of a lancet.

"It is probable also that a simple inoculation with a lancet charged with syphilitic blood would produce no positive result. But if, according to the experiments of Waller of Prague, the skin be first scarified, and the infected blood be introduced with an appropriate instrument into each scarification, there is a good chance that the experiment will succeed, as it did in Waller's hands."

Waller's experiments are so much to the point, and of so much importance, that they cannot be overlooked in the investigation of this subject. Among others he relates the following:

"The skin of a boy, who had never had syphilis, was scarified with a new scalpel. Some blood was then drawn by means of a cupping-glass from a patient affected with secondary syphilis, and inserted into the scarifications on the boy's skin by means of a piece of wood. Some lint soaked in the same blood was placed over the scarifications and allowed to remain. No immediate inflammation or suppuration followed this operation, and at the expiration of three days the wounds had all healed; but thirty-four days after this experiment, two distinct tubercles appeared on the inoculated part. These were the size of a pea, of a pale-red colour, unattended by suppuration, pain, or itching. On the following day these tubercles increased in size, so that they became united at their bases. They were scaly upon the surface, and surrounded by a deep red areola. They gradually increased in size and assumed a copper hue. The skin and subjacent cellular tissue which formed the base of the tubercles became hard and dense, while their surface ulcerated, and was covered by a thin brown crust.

"A fortnight after this, an ulcer was developed with a base as large as a pigeon's egg, surrounded by a red, copper-coloured circle, and covered by a crust similar to that above mentioned. A single tubercle, the size of a pea, now formed upon the right shoulder; the surface of this was red and covered with scales. After the lapse of another fortnight the patient became feverish and restless.

"A month after the appearance of the first tubercle, an eruption appeared over the lower part of the stomach, on the back, on the chest, and on the thighs. This eruption gradually covered the whole body, and was accompanied by neither itching, pain, nor fever."

Dr. Waller gives the names of several eminent men who recognised this eruption as syphilitic. He concludes that

"Primary and secondary syphilis are capable of inoculation. The pus of a chancre produces a chancre. The products of secondary affections give rise to secondary affections."*

Of what practical value, then, amongst the conflict of opinions, are we to consider syphilitic inoculation? As a means of diagnosis, we must allow, that when the characteristic pustule is produced, it affords satisfactory evidence of the nature of the disease. This mode of ascertaining the nature of the affection we have to deal with may be of much service where ulcers have appeared in unusual situations; and where from this or other causes they have not assumed their common appearances; and to M. Ricord we would accord the full credit of this discovery.

But can we with equal certainty say, that when inoculation fails, the disease is not syphilitic? Certainly not. With the amount of evidence before us, we cannot regard the broad distinctions sought to be established by M. Ricord and his followers as correct. To affirm that all primary chancres can be inoculated because they are syphilitic, and that they are syphilitic because they can be inoculated, is simply to beg the whole question.

Experience proves that we cannot rely upon the negative results of inoculation; and that a primary affection, although not capable of being inoculated in the ordinary way, may nevertheless be followed by secondary symptoms.

In a paper in the thirty-sixth volume of the *British and Foreign Medical and Chirurgical Review*, for the year 1856, several cases are published by me in which the primary sores afforded no inoculable pus, and yet they were followed by secondary symptoms. What, then, is the sum of positive knowledge which we derive from the practice of inoculation as a means of diagnosis? It undoubtedly furnishes us with a ready means of testing the nature of some particular kinds of ulceration. If properly performed, it will nearly always afford a positive result in a class of syphilitic sores, having distinct and easily recognisable physical characters, and which are affected with *suppurative inflammation;* but it will as often fail in another class also distinct, where the inflammation is of the *adhesive* character. The great distinction between these two divisions of cases will be fully dwelt upon in the chapters on local and constitutional syphilis.

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* *Du Caractère contagieuse de la Syphilis secondaire*, par Dr. Waller, traduit par M. Axenfeld; *Annales des Maladies de la Peau et de la Syphilis*, avril 1851.

It is maintained by Dr. Sperino, M. Auzias Turenne, and others, that inoculation may not only serve as a means of diagnosis, but also as a means of preserving the system from the action of the syphilitic poison, or of curing the syphilitic disease when the constitution has become infected by it.

This mode of practice is not likely to be seriously entertained in England, and the facts hitherto published with regard to it require confirmation. They cannot, however, be overlooked, and have at least this effect, that they tend to disabuse the minds of professional men, and through them of the public, of an idea that has very generally prevailed, namely, that the severity of the constitutional symptoms, and the frequency with which they occur, bear some proportion to the number of primary sores. From Dr. Sperino's book it would appear that in no case were the inoculations which he practised followed by any serious results; a slight surrounding inflammation or a transient phagedænic ulceration is the sum of the much-dreaded consequences which are said to have followed. Nor can it be said (if his work at all corresponds to his motto, *non verbis, sed factis*) that he has not given the plan a thorough trial. If very serious results were likely to happen, Dr. Sperino ought to have met with such, for he has been by no means sparing in the number of his inoculations. Out of fifty-three cases of primary syphilis, we have fifty-two treated by repeated inoculation or, as it is termed, by syphilisation. In these the plan is said to have been successful in fifty, and unsuccessful in two cases. Out of forty-three patients affected with constitutional syphilis, twenty-six were treated by syphilisation, and twenty-five were cured. In six instances the iodide of potassium was used in conjunction with syphilisation, and in eight cases syphilisation, iodide of potassium, and mercury were all employed. In three cases it was found necessary to discontinue the inoculations, and two patients died. Of the fifty-three patients treated for primary syphilis, only three presented themselves subsequently with secondary affections; and in these the disease is said to have been cured by fresh syphilitic inoculations. With reference to the comparative frequency with which secondary affections may be expected after this plan of treatment, we cannot tell how much the popularity or the inconvenience of the mode of treatment may have influenced its apparent results. Whenever a new plan of treatment has failed, or has been attended with much inconvenience, it is not likely that the patient will again have recourse to it. This remark may apply with peculiar force in the present case, where the plan adopted must necessarily have been met at first with a very general feeling of distrust. But the result with which we are chiefly struck is, that amongst the patients who were said to be cured of constitutional syphilis by syphilisation, no case presented a recurrence of the disease. This, we believe, is a more favourable result than can ever be expected from any plan of treatment.*

A very important point remains to be considered, namely, what length of time was occupied in the treatment of these cases. Excluding the cases treated with mercury and the cases in which the treatment was interrupted, Dr. Sperino gives us seventy-six cases, in which the supposed immunity against the effects of syphilis, acquired by repeated inoculation, might be observed. Of these, the cure is said to have been effected in less than a month in one case; in from one to three months in four cases; in from three to six months in seven; in from six to nine months in eight; in from nine to twelve months in eight; in from twelve to fifteen months in twenty-one; and in from fifteen to seventeen months in twenty-seven. In this analysis we cannot but observe the relation between the gradually increasing number of cases and the length of time required for their cure; and we are not surprised to find that no case should have returned after having been treated upon this plan from fifteen to seventeen months.

We are informed that in this mode of treatment the ulcers first produced by inoculation cause some suffering, but that subsequently the patient may attend to his usual business, and appear to be in his accustomed health. The cicatrices produced by the inoculations are said to be in the majority of instances small and superficial, leaving very little evidence of their existence. Occasionally, however, the ulcerations have become phagedænic or gangrenous, and then the traces of their existence have subsequently been visible enough.

The practice of syphilisation is advocated for primary ulcers, which it is said soon lose their characteristic hardness and begin to cicatrise. Buboes, also, are beneficially acted upon by this treatment. Vegetations, on the contrary, are not influenced by the practice; but cutaneous syphilitic eruptions, secondary syphilitic ulcerations of the skin or mucous membranes, the loss of hair, and the deep subcutaneous ulcerations of the cellular tissue, are all said to be cured by this plan. Syphilitic iritis has also been treated in this way successfully. Periostitis, necrosis, and caries, are likewise supposed to have been brought under its magic spell. But before we can draw any inference from the facts stated, supposing them to be all strictly true, we should require an equal number of similar cases in which no treatment at all was pursued; and it might be difficult to say in which of the two classes of cases the disease would prove the most severe or would last the longest.

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* A gentleman of my acquaintance, travelling for amusement in the East, thought he would improve his opportunity and bring to bear the smattering of medicine which he had picked up in England; and in some places he appears to have gained a considerable reputation among the natives. He had heard that a strong solution of caustic was a good remedy for inflammation of the eyes; and accordingly he adopted this plan of treatment. The result was, that he cured them all; they never came again!

Professor Boeck, of Christiana, has lately used syphilisation both in adults and in infants. He only employs this so-called remedy in cases of constitutional syphilis. The matter is inoculated in the same way as the vaccine poison. In order to prevent large ulcers and cicatrices, he begins his inoculations on the sides of the trunk. Three inoculations are made on each side. After three days he finds pustules produced, and from these he makes at that period fresh inoculations. In this way he continues inoculating every third day, always taking the matter from the last pustules, until it is no longer possible with this matter to produce any effect. Matter from a fresh patient is now used, and will produce pustules in the same way as the first; the pustules and ulcers resulting from this second matter are not nearly so large as those produced by the first inoculations. If a third matter be now taken, it will produce pustules and ulcers, but still smaller and fewer in number; and at last a time arrives when no matter applied to the sides will produce any specific effect. Still, however, Prof. Boeck finds that the thighs are susceptible to inoculation either from fresh matter or from matter of the last pustules. The process is now repeated on the thighs, until an immunity is there also obtained.

The conclusions arrived at by Professor Boeck are:

1. That artificial chancres on the sides and on the arms are always smaller than those on the thigh, and the series of inoculations shorter.

2. By continued inoculation the ulcers always become less and less, until at last the inoculations give a perfectly negative result.

3. The inoculated individual grows insensible to one matter, but is still susceptible to another, yet in a lower degree; and again

to a third matter, but in a still lower degree; and so on until no further effect is produced by any matter.

4. Immunity having been obtained on the sides and on the arms, it will still be possible to have rather a long series of inoculations on the thighs.

All these phenomena, the Professor remarks, are constant: they will not be seen in one individual and missed in another; they will always show themselves. "*We have here an invariable law of nature.*"

Professor Boeck draws the conclusion that the inoculations produce a general effect upon the organism, as shown by the later inoculations always being less efficacious than the former; and if so, it must be allowed that *an* effect is produced upon the system of the patient; but that this effect is produced by the absorption of the inoculated syphilitic virus by no means necessarily follows. The absorption of the syphilitic poison is marked by a well-ascertained series of symptoms, which leave no doubt as to its presence. The symptoms which it produces have very rarely (if ever) been known to accompany artificial inoculations such as that above described. What evidence have we, then, of any absorption of syphilitic poison after pustular syphilitic inoculation? The truth appears to be, that these cases of repeated pustular inoculation very much resemble those of natural syphilitic inoculation in certain classes of patients, such as those lately brought under the notice of the profession in a work by M. Labatt. In his observations, which were confined to soldiers, he saw very few indurated sores, and very few cases of secondary symptoms. The cases of repeated natural and artificial inoculation appear analogous. In both the ulcers are usually of the soft and suppurative kind; in both a kind of immunity more or less perfect may (in some cases at least) be acquired; and in both there is an entire absence of what are usually considered constitutional symptoms. What ground have we, then, for saying that absorption of syphilitic matter takes place after artificial inoculation, unless we allow the same to occur after the oft-repeated inoculations to which some of the lower orders of both sexes not unfrequently subject themselves, but which we see produce no constitutional symptoms, and are commonly recognised as non-infecting sores?

The examples of syphilitic disease given in M. Labatt's work are, from peculiar circumstances, almost exclusively those of one class. The examples of inoculation given by Professor Boeck are in like manner confined to the inoculation which produces the suppurative form of inflammation. A grand error has been committed from a general and ready acquiescence in the doctrine that syphilitic inoculation is always followed by the same results, and hence much confusion has arisen. In order to avoid this for the future, it will be necessary to distinguish between the inoculation which gives rise to the suppurative form of inflammation, and that which produces the specific adhesive inflammation. Inoculation, whether artificial or natural, when it gives rise to the suppurative form of inflammation, will, as a rule, be followed by no constitutional symptoms; but if, on the contrary, it gives rise to the adhesive form of inflammation, in the one case as in the other secondary symptoms will follow.

It was in the year 1851 that Professor Boeck, travelling through the northern part of Italy, had his attention drawn to the new doctrine of syphilisation. On his return he was resolved to try the new plan as soon as he was "able to obtain some inoculable virus." *This was not until the month of October* 1852. Surely this fact, we should have thought, would have suggested to the Professor the idea, that the inoculation of the syphilitic poison does not always follow the same course, or produce the same results. He cannot mean to say that during the period mentioned he had no case under his observation that he thought would be capable of communicating the disease in a natural way. If so, the disease in Christiana must be well-nigh extinct: what Professor Boeck evidently means is, that he was waiting for some pus which would produce well-formed pustules, or well-marked examples of the suppurative inflammation. But the fact, which we must take for granted, that he had under his observation at the time other cases which he well knew would be capable of communicating some form of syphilitic disease, shows plainly that he instinctively knew that the syphilitic disease was not always communicated by exactly the same morbid process. Artificial inoculation may doubtless give rise to the adhesive form of inflammation (or to an indurated sore), as well as to suppurating or to soft sores. The results of these different forms of disease will be as distinct in the artificial as if they had been acquired in the natural way.

Professor Boeck believes that syphilisation is the proper mode of treating syphilis, and that "in no disease have we a more certain method of cure." It is true that this mode of cure is, according to the Professor's own showing, somewhat protracted, and is even followed by fresh syphilitic symptoms; but to these he pays no attention whatever, and says that they disappear of their own accord.

"If an individual suffering from severe constitutional syphilis can be assured of a certain cure in about six months, I think it must be allowed that the time is well employed. Immunity having been produced, and the symptoms existing at the beginning of the treatment having disappeared, new symptoms generally show themselves, especially sores on the mucous membrane of the mouth or fresh exanthematic eruptions or iritis. These disappear without treatment."

It appears from the above extract, that after immunity to further inoculation has been produced, fresh symptoms may be expected; and yet Professor Boeck says, "whether this alteration (indicated by the immunity to further syphilitic inoculation) proves that the syphilitic virus no longer exists in the organism at all, I dare not say with certainty." It would appear from this that the Professor had some idea that the immunity to syphilitic inoculation and the existence of the syphilitic virus in the system were in some way necessarily connected. In order to clear up this point, it must be at once distinctly stated, that the immunity to syphilitic inoculation is one thing, the existence of constitutional syphilis another. These have no necessary connexion with each other, and indeed, according to the Professor's own experience, where this immunity has been produced, unequivocal constitutional syphilitic symptoms "generally show themselves" at some subsequent time. Although, therefore, we look upon Professor Boeck's experiments as giving us very valuable physiological and pathological facts, we do not see that he has at all established his position that syphilisation is the best and most certain method of curing syphilis.

CHAPTER II.

Pathology of Syphilis.

The opinions of Hunter concerning the use of the absorbent vessels have given a bias to all subsequent reasonings upon this subject; and the theories based upon his experiments are commonly received, even up to the present time. Hunter, assisted by his brother, and by Drs. Clayton, Fordyce, Michaelson, and others, found that when he confined some warm milk in a portion of small intestine, and tied the artery and vein which supplied it, the lacteals of the part were presently filled with the white milk. Upon puncturing the vein upon the distal side of the ligature, it was soon emptied of its blood by pressure with the finger; but no white fluid could at any period during the continuance of the experiments be seen in the vein. Upon a repetition of the experiment, in which the circulation through the mesenteric vessels was left free, the blood in the vein was carefully examined and compared with that in the neighbouring veins, but it was found not to be light-coloured, nor milky, nor could any difference whatever be detected in it. It was found that even by firm pressure (which was continued until the intestine burst) the milky fluid could not be made to pass into the veins. In another animal, some thin starch, coloured with indigo, was introduced into the small intestine, and the lacteals soon appeared to be filled with a fluid of a fine blue colour. A vein in this part of the mesentery was opened, and the blood which flowed was allowed to separate into coagulum and serum. The next day the serum had not the least bluish cast. An injecting pipe was then fixed in an artery of the mesentery, where the intestine was filled with blue starch, and all communications, both in the mesentery and intestine, were closed, with the exception of the vein corresponding with the artery. Warm milk was then injected by the artery until it returned by the vein. This was continued until all the blood was washed away, and the vein returned a bright white milk. The milk thus circulating through the intestine containing the coloured starch was not in any degree changed in colour. In a third animal, some musk in warm water was confined in a portion of intestine. After waiting a little time, some of the lacteals of the part were opened with a lancet, and some of the watery fluid which they contained was received into a small spoon. This was found to smell strongly of musk. Some blood received in a clean spoon from one of the veins of the same part had not the least smell of musk.

From these and similar experiments, Hunter arrived at the inference "that the red veins do not absorb in the human body;" and consequently that the lymphatics were "the only absorbents."* These premises naturally led to the further conclusion, that poisons were necessarily absorbed by the lymphatic vessels; and accordingly we find Hunter asserting "that the venereal matter is taken up by the absorbents of the part in which it is placed, and carried along the absorbent vessels to the common circulation."†

This view, deriving, as it does, such an apparent confirmation from the frequent occurrence of inflamed lymphatic glands in conjunction with venereal ulcers, has been adopted, with more or less modification, by almost all subsequent writers.

The accuracy of the experiments upon which Hunter based his theory has justly been called in question by other physiologists, but the theory itself, strange to say, has hitherto scarcely been questioned. MM. Tiedemann and Gmelin, after mixing various substances, which might easily be detected, with the food of animals, not unfrequently found unequivocal traces of these substances in the venous blood and urine, whilst it was only in a very few instances that traces of them could be discovered in the chyle. In repeating Hunter's experiments, Mayo proved, that half an hour after a solution of starch and indigo had been placed in the cavity of the intestine, the lacteals appeared of a clear blue colour, and those present were for a short time satisfied that the indigo had been absorbed. But upon placing a sheet of white paper behind the mesentery, it was found that the blue tinge disappeared,—the vessels were simply empty. On removing the white paper, they reassumed their blue colour. Thus a repetition of the Hunterian experiments rather goes to prove that the function of the lacteals is limited to the absorption of chyle. But perhaps the most conclusive experiment on this subject is that of M. Ségalas. A fold of small intestine was drawn out of a wound in the belly of a dog. All the blood-vessels passing to and from it were tied but one large artery. A vein, punctured upon the mesentery, allowed the blood to escape, which would otherwise have stagnated in the part. The lacteal vessels and nerves were left entire. The fold of intestine was then tied at both extremities, and an aqueous solution of the alcoholic extract of nux vomica was poured into it. During the hour which followed, the poison produced no symptoms. The ligature being then removed from one of the veins, the blood was allowed to return in the natural course of its circulation. In six minutes from this time the poison took effect. The experiments of M. Magendie, illustrating the same point, in which the poison of the upas tienté was introduced into the system of a dog, through a limb which had no connexion with the body, excepting through the blood-vessels, are well known.

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* *On the Venereal*, p. 253.

† Ibid. pp. 256, 257.

From these facts it appears certain that Hunter's idea of the lymphatics being the only absorbents is incorrect, and we are thence naturally led to the consideration of the value of the theory which was based upon that notion.

An extensive observation of cases of syphilis will establish the two following very important points in relation to this subject: first, that in those instances in which the irritation of the lymphatic glands is the greatest, and where, consequently, we have the best evidence that the morbid matter has entered them, there is very seldom indeed any secondary syphilitic affection; and secondly, that the best-marked cases of constitutional infection are as rarely preceded by any very evident signs of inflammation of the absorbent glands. In the first class of cases we may trace, in the most satisfactory manner, the progress of the syphilitic virus along the absorbent vessels as far as the first lymphatic gland that it meets. In any part of this course the poison may be arrested, and produce a fresh chancre, thereby affording unequivocal evidence of its presence. But neither experiment nor observation affords any proof that the virus is conveyed unchanged through these glands. All the evidence which we have upon this subject tends to an opposite conclusion. Hunter himself says: "We never find the lymphatic vessels or glands that are second in order affected. When the disease has been contracted by a sore or cut upon the finger, I have seen the bubo come on a little above the bend of the arm, upon the inside of the biceps muscle; and in such where the bubo has come in that part, none have formed in the armpit, which is the most common place for the glands to be affected by absorption."*

In like manner, after artificial inoculation, we may trace the poison, in many cases, along the lymphatic vessels, as far as the first absorbent gland which they enter. Here, however, some change is produced. Beyond this the specific characters of the poison can no longer be detected, either by its natural effects or by artificial inoculation. After the virus has undergone digestion or concoction in a lymphatic gland, it is no longer capable, either locally or constitutionally, of producing its specific effects. The grounds upon which it has been assumed that the syphilitic poison enters the system through the absorbent vessels, are therefore most inconclusive. The usual mode in which the system does become infected by syphilis may be traced in another and a much more satisfactory manner.

In the development of primary syphilitic disease two processes may distinctly be recognised: one, that by which the surrounding tissues become indurated; the other, by which the same parts are ultimately removed. This second result may be accomplished either in the natural process of growth, by ulceration, by sloughing, or by different modifications of these. But beyond the parts which are involved in these processes other actions are going on, of a more subtle nature, and not so easily appreciable by our senses. In the absence of more positive knowledge, these may be ascribed to the molecular changes in the nutrition of the parts surrounding a chancre. That such actions are in active operation beyond the sphere both of the adhesive and ulcerative processes may be readily demonstrated, although we may be unable to define their exact nature. Were this not so, we should have nothing to do in the case of a primary syphilitic sore but entirely to remove the indurated and ulcerated tissue, and the disease would, as far as the part is concerned, be at an end. Experience proves that such is very far from being the case.

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* Op. cit. p. 260.

When a syphilitic sore is removed by excision, as may readily be done when it is situated on the extremity of the prepuce, the cut surface will in a few days take on a specific action. This will occur, as I have witnessed, even when the greatest care is taken not to allow any of the matter from the chancre to come in contact with the cut surface. Such an action taking place in a part apparently healthy, at some little distance from the original sore, presupposes some antecedent change in the tissues in which it originates,—a change produced by the infecting poison, but not capable of being appreciated so long as the diseased action had its development in the original chancre. As soon, however, as the first centre of the morbid action is removed, a similar action is commenced upon the neighbouring cut surface. The observation of such cases proves the existence of a subtle morbid process affecting the tissues in the neighbourhood of the part first affected, and necessarily producing *some* effect upon their nutrition. It appears, under these circumstances, much more in accordance with that which is known to happen in the case of other poisons, to suppose, when the constitution becomes affected with syphilis, that the disease is communicated directly to the blood circulating through the parts in which the above-mentioned morbid actions are going on, than to refer the symptoms to the passage of the poison primarily through the absorbent system.

When the constitution becomes affected in consequence of the inoculation of the vaccine or the variolous poison, an affection of the lymphatic vessels and glands certainly forms no essential part of the process. Few, indeed, have thought it necessary to invoke the aid of the absorbent system in order to account for the action of these poisons upon the animal economy, and it is equally unnecessary in the case of the poison of syphilis.

It has appeared necessary thus to enter at length upon this subject, to prepare the way for the consideration of the marked difference which exists between the effect of the entrance of morbid fluids (even if impregnated with syphilitic matter) into the lymphatic vessels, and the absorption of the syphilitic virus into the constitution.

M. Vidal, with Hunter, acknowledges four kinds of absorption of the syphilitic poison, by means of the lymphatic vessels:

1st. Where the venereal matter has been applied to a sound surface, and has produced no local effect upon the part, but has been absorbed immediately upon its application.

2d. Where the absorption takes place from an inflamed surface. Such is the way in which a bubo is formed in cases of gonorrhœa, some of which M. Vidal maintains to be really syphilitic, although there may be no ulceration of the urethra.

3d. Where the syphilitic poison enters the absorbent glands from an ulcerated surface; and, 4th, from a wound. All these four kinds of absorption by the lymphatics may be observed, but it by no means follows that any one of them is the channel through which general syphilitic infection is produced.

Independently of these means, a bubo is said, by many authors, to originate from sympathy. M. Vidal justly asks, sympathy with what? Whence does this sympathy originate? How is its influence determined to one particular part?

This word "sympathy," as applied to the formation of buboes, appears most unintelligible. We can readily conceive that parts which have a natural relation to each other may be affected by sympathy. Thus we can easily believe that the breasts may sympathise with the uterus, or the testicles with the urethra. But that one particular class of absorbent vessels should have a peculiar sensibility for the diseases of another part with which they have no particular connexion (independent of the transmission of their contents), it is difficult to imagine. That an uncertain amount of an unknown influence should in this unknown way be conveyed from one part of the body to another, must be regarded as one of the mysteries of an occult science. MM. Maisonneuve and Montanier, following Ricord, divide syphilitic affections of the absorbent glands into those in which the glands are enlarged (*engorgement*), and those in which they are manifestly inflamed. To the latter they apply exclusively the term bubo.

"The real bubo," it is said, "is only found with unindurated chancre; the indurated chancre only is, on the other hand, accompanied with an indurated enlargement of the glands: from this it consequently follows that a bubo properly so called, like the chancre which precedes it, is only a local affection, and never a sign of the infection of the system. If the chancre is already healed, a bubo will indicate that it was unindurated; an indurated enlargement of a gland, on the other hand, will without doubt afford evidence that an indurated chancre has existed, or is still present."*

"The induration of a chancre is the certain proof of a constitutional infection. It is necessarily accompanied by an indolent enlargement of the absorbent glands nearest the seat of the disease, and in a longer or shorter interval, generally within six months, is necessarily followed by constitutional symptoms, when not prevented by medical treatment."†

"The bubo is of no consequence, but as a local disease; the enlarged ganglions are of the highest importance in relation to constitutional syphilis."‡

"A simple chancre accompanied by a suppurating bubo never communicates constitutional syphilis."§

M. Vidal does not allow that the condition of the absorbent gland is of the value as a diagnostic sign which is implied above. Inflammatory bubo, he justly says, may come on independently of the absorption of any syphilitic matter, and the indolent non-inflammatory bubo may happen in consequence of strumous affections, as a result of a simple unindurated chancre, or as a secondary syphilitic affection. The observations of Dr. Egan, again, have led him to conclusions somewhat differing from those of M. Ricord.

"Buboes," he says, "usually consequent on gonorrhœal inflammation, are uninoculable, although here a mild description of secondary symptoms is occasionally met with."‖ Dr. Egan believes likewise that, after abrasions of the mucous membrane, and also after superficial non-indurated primary ulcers (whether the secretion from them is capable of being inoculated or not), a mild form of constitutional symptoms may ensue.

The opinion of the French school, represented by MM. Ricord, Maisonneuve, Montanier, Robert, &c., is, as we have seen, opposed to these views. These gentlemen find, that whenever they have had an opportunity of tracing the natural progress of the disease, an indurated chancre is always communicated by an indurated chancre, and they believe that this alone will give rise to constitutional syphilis.

The experiments and observations of Dr. Egan have led him to the conclusion that there are two syphilitic poisons. From the fact that when the matter of a phagedænic ulcer is successfully inoculated, the result is an ulcer presenting the same characters, he infers "that the virus generated by the simple primary ulcer and the phagedænic sore is as dissimilar in quality as it is in its effects."*

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* Maisonneuve, pp. 164, 165.

† Ibid. p. 165.

‡ Robert, p. 211.

§ Ibid. note, p. 140.

‖ Egan, p. 39.

The results of the experiments upon which this idea is founded are manifestly inconclusive, because the inoculations were made on the patients themselves, in whom the primary affections had already assumed a phagedænic character. It is likely enough that, if in these patients one venereal sore presented a phagedænic character, a second or third would do so likewise. In order to be of any real value, the experiment must be performed upon persons who have not previously had the venereal disease, and whose constitutions are free from any unusually disturbing influences. As such experiments, for obvious reasons, cannot with propriety be performed, we are thrown back for our facts to clinical observation and to the information which may have been obtained from inoculating patients already infected. From the former the point cannot well be established; and from the latter it has been shown that ulcers produced from the inoculation of the discharge of simple venereal sores will sometimes become phagedænic.

"If pus, taken from a simple non-indurated sore which has lasted a fortnight, and is accompanied by inflammatory bubo, be inoculated, a simple venereal ulcer will result, provided the inoculation be properly performed. This ulcer may become phagedænic, serpiginous, or gangrenous. But it never will produce an indurated sore."†

If, then, the virus from a simple sore will produce a phagedænic ulceration, as we have no doubt it will, we cannot regard the effect as depending upon any peculiarity in the poison.

In reviewing the whole of the works which have recently appeared on the subject of syphilis, we find, after all the experiments which have been made, and after all the attention that has been directed to the subject, that authors are not agreed as to what precise forms, either of primary or secondary venereal affections, are capable of affording a secretion which may be absorbed so as to infect a healthy person. They have hitherto failed to associate the external appearances of particular kinds of primary affections with any definite forms of secondary disease resulting from them as a necessary consequence. We have at present no generally recognised and well-defined mark of distinction, independent of inoculation, between those diseases which are syphilitic and those which are not. Upon the subject of the absorption of the syphilitic poison in particular, it must be allowed that the accounts are sufficiently obscure. Something more satisfactory may probably be arrived at by attentively considering the earliest stages of the morbid processes which are involved in the absorption of the syphilitic poison. The great author of this mode of investigating morbid actions has prefaced his treatise on the venereal disease with the following remarks, which require no apology for being introduced here, as they have never, perhaps, received the amount of attention which they deserve, and have never been applied in their full extent to the illustration of our present subject. "No two actions," says Hunter, "can take place in the same constitution, nor in the same part, at one and the same time; no two different fevers can exist in the same constitution, nor two local diseases in the same part, at the same time."

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* Egan, p. 54.

† Maisonneuve, p. 139.

It might appear strange to any one who had not considered the subject in its physiological relations, that these ideas should occupy so prominent a position in Hunter's work on the venereal disease, and that they should be dwelt upon in this rather than in any other of his writings. Nevertheless, they are the principles upon which much that is apparently obscure in relation to this disease may be explained, and they afford a remarkable instance of that intuitive insight so peculiar to our great physiologist, by which comprehensive general ideas were appreciated in their extent and simplicity, even where their applicability to particular details might not have been traced.

For truth and clearness, the description of a primary syphilitic ulcer has not been excelled since Hunter's time. "A chancre has commonly a thickened base, and although in some sores the inflammation spreads much further, yet the specific inflammation is confined to this base." This *specific* action, in which the arteries throw out coagulable lymph, depends, according to the Hunterian nomenclature, upon *adhesive inflammation.** The action by which pus is formed is named *suppurative inflammation;** and that which removes parts, the *ulcerative inflammation.** These three effects of inflammation Hunter regards as distinct actions, and therefore incapable of being produced in the same part at the same time. Now that which is peculiarly characteristic of the syphilitic action in a part is a specific adhesive inflammation, which has no connexion at all, and indeed, according to the Hunterian doctrine, is incompatible, with the ulcerative inflammation. And as it has been shown that there is no evidence that the poison is taken into the system by absorption (through the lymphatics), it is clear that ulceration may form an accidental, but not necessary, part of that process by which the syphilitic poison enters the general circulation. This peculiar form of the primary disease is the only one of an inflammatory nature which we can, in a satisfactory manner, trace as peculiarly and necessarily connected with secondary affections. The specific adhesive inflammation is for syphilis what the vaccine vesicle is for the cow-pox—at once a local manifestation that the disease has affected the tissue of the part to which it has been applied, and an evidence of its subsequent and consequent influence upon the constitution.

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* The term "inflammation" is here retained as having been used by Hunter. But if we had a word in common use signifying "diseased action" or "morbid process," it might with much advantage be substituted for "inflammation."

When, on the other hand, a part inoculated with the syphilitic virus is affected with the ulcerative inflammation only, or when the inflammation which it produces is accompanied with a free secretion of pus, or when the parts affected mortify at an early period, then the disease, as far as its specific characters are concerned, will be a local one.

Varieties of Primary Syphilis.

When syphilitic matter is applied to the surface of the human body, no appreciable effect in general results; but when the poison comes in contact with the thin skin in those situations where it joins the mucous membrane, or when applied to the mucous membrane itself, or to the skin in places where the epithelium has been removed, then inoculation may take place. As observed in practice, the results of this process afford considerable variety; when artificially performed, they have been much more uniform.*

Four distinct and well-marked morbid processes may follow syphilitic inoculation:

1st. The inoculated part may become affected with the "adhesive form of inflammation," in which lymph is poured out either in the substance or on the surface of the part.

2d. The inoculated part may, within a few days of the application of the poison, be affected with suppurative inflammation.

3d. The absorbents may assume an active share in the morbid process, and taking up some of the infected parts and with them portions of the syphilitic poison, produce an acute inflammation of a lymphatic gland. For the sake of distinction this form of the disease will be called in the following pages "ulcerative inflammation."

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* See p. 377.

4th. The morbid action may terminate in mortification. Of this there are two practical subdivisions:

(*a*) Death of the whole infected part, which is then thrown off as a slough; and

(*b*) Dissolution and death of a part only of the contaminated structure, leaving a part still infected.

These four kinds of morbid processes, essentially distinct when once developed, usually maintain their original character until the termination of the disease. Thus a primary sore affected with adhesive inflammation may be recognised by its characteristic induration often long after the sore (which usually accompanies it) has permanently healed. But it will nevertheless occasionally happen that the action will become changed, and this altered condition (if careful attention be not paid to it) will lead to an error in the diagnosis. A sore affected with adhesive inflammation, upon the application of some fresh irritant may become a suppurating sore. The superinduced action may perhaps modify, but will not prevent, the specific results of the original disease; or again, a sore that has presented for a time the characters of the suppurative inflammation will alter its appearance and assume those of the adhesive form. In such a case, the first disease will not prevent the constitutional effects of the second.

It will sometimes, but very rarely, happen that a sore affected with adhesive inflammation will, upon the application of some fresh irritant, 'ulcerate' (in the specific sense of the term), so as to give rise to inflammatory bubo; but this is only an accidental and very exceptional occurrence. It will also sometimes happen that the specific adhesive inflammation may terminate in mortification, or that a part superficially mortified may become affected with specific adhesive inflammation. In either case, the extent of the mortification may be superficial or extend to the whole of the infected tissues; but if the specific adhesive inflammation has once taken place, its specific effects upon the constitution will subsequently appear.

The above four kinds of diseased action, resulting directly from the application of the syphilitic poison to the surface of the body, may be clearly traced both by artificial inoculation and by attentively observing the natural course of the disease in different instances. It must, however, be borne in mind that the character of a sore at one time is no certain indication of what it may previously have been, or of what it may ultimately become. In the mode in which the disease is usually communicated, a part may be subjected to influences which would have a tendency to produce more than one morbid action. Such influences may be applied either at the same or at different times. When applied at the same time, one action only follows usually in the same part; but when applied at different times, the action may be modified or changed in the various ways above mentioned. The influences here alluded to consist mainly of mechanical irritation, and the contact of various irritating discharges.

CHAPTER III.

CONSTITUTIONAL SYPHILIS.

Primary Syphilis. Infecting Sores. Specific Adhesive Inflammation.

The only local disease that can be associated with constitutional syphilis as a cause is a sluggish indolent form of adhesive inflammation. This affection usually commences as a crack, an abrasion, or a pimple. It is accompanied by little pain, redness, or swelling, unless irritated by caustic or some other artificial means.

The appearance of the primary infecting sore presents considerable variety. When allowed to run its natural course uninfluenced by treatment or by accidental circumstances, the following are the symptoms:

At an uncertain period, but generally from three to five days* after exposure to infection, attention may be drawn to the part by a slight itching. On examination, a red spot, surrounded by a little induration, will perhaps present itself, or a vesicle about the size of a millet-seed will not unfrequently form upon the infected part. The cuticle covering this vesicle is so thin that it usually gives way at a very early period; and this, in fact, in a large proportion of cases, happens before the disease has been carefully examined. The base of the vesicle then becomes indurated, and the induration (whether preceded or accompanied by a pimple or a vesicle, or independent of either of these) assumes a circular form, extending an equal distance in every direction, and terminating quite abruptly in apparently healthy parts. A sore generally follows; this is excavated, without granulation, sometimes glazed, at other times having some adhesive matter on its surface. The colour of the chancre will depend often upon the amount and character of the substance which adheres to it, and will frequently present a fawn hue or different shades of brown or red. When this adventitious matter is removed, the sore will usually again assume its original smooth and red glazed appearance.

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* Several cases have presented themselves to me in which there appeared to have been no possibility of contagion for a month before the appearance of the adhesive form of primary syphilitic disease.

In cases where there is little, if any, loss of substance, the surface of the infected part is covered with epithelial scales. The affection here consists of an indurated knot or tubercle, imbedded in the natural structure; and cases occasionally, though rarely, present themselves in which neither patient nor surgeon can discover any breach of surface whatever. When loss of substance does take place (and this very generally happens), successive layers of matter are thrown off from the surface of the chancre. These layers are composed partly of the original texture of the part, which perishes by a kind of molecular necrosis, and partly of the adventitious lymph which constitutes an interstitial deposit, and which perishes in the same manner. By this process, which should be carefully distinguished from that of ulceration, the sore gradually becomes larger, extending generally, like the preceding induration, in a circular form.

The secretion from its surface is small in quantity, often resembling turbid serum. This, when placed under the microscope, is found to contain comparatively few globules. In general it consists chiefly of epithelial débris, floating in a transparent fluid. If acetic acid be added to the secretion before it is placed under the microscope, most of the globules will be dissolved, and if any nuclei are left, they will be of various shapes and sizes, and sometimes opaque, —very different in appearance to those left under similar circumstances when the secretion is taken from a suppurating sore. It will occasionally happen that a primary infecting disease of this nature will afford no secretion at all from the surface; it will, in fact, be covered in every part by epithelium, and the débris of the epithelium is all that can be obtained from it.

The induration is the most characteristic sign of a primary infecting sore, but it may nevertheless be simulated by the adhesive inflammation from other causes. Thus, the application of nitrate of silver may cause a certain amount of adhesive inflammation, but this is generally of a very limited extent, and disappears after the lapse of a short time. Again, the effusion of lymph, which precedes or accompanies the formation of pus, may give rise to a considerable amount of induration; but this will disappear gradually in the surrounding parts, and will not terminate abruptly, as in the primary infecting sore. The induration of a chancre is sometimes very superficial, not thicker than a piece of parchment, but it still maintains its character of terminating abruptly and of being of uniform thickness throughout.

In one case only is the induration of the primary infecting sore entirely wanting, and that is when it is situated in the upper and central portion of the glans penis. The infecting sore here assumes quite a peculiar appearance. The surface is red; it yields little secretion; and it looks as though the epithelium had been removed without exciting any irritation in the structure beneath. The infected part will remain in this condition for days or weeks together without undergoing any alteration, and without presenting the least trace of induration. But although it does not become indurated itself, it may be followed by induration of neighbouring parts, which have not themselves been ulcerated.

Case I. A clerk in a government office (married) exposed himself to contagion on the 24th of March 1856. When I first saw him, on the 2d April, there was a red superficial glazed sore on the glans penis. The appearance was such as might be produced by peeling the cuticle off and allowing the raw surface to dry. A very little secretion was noticed upon the sore. Some of this mixed with acetic acid and placed under the microscope exhibited globules of tolerably uniform size, spherical and opaque throughout. No nuclei could therefore be detected.

Recognising this sore from its general appearance, I examined most carefully to ascertain whether it was accompanied by any induration, but I could detect none. This patient attended regularly, and upon each visit a similar examination was repeated, with a like result.

On the 29th April a well-marked syphilitic eruption made its appearance; and now, for the first time, induration of the prepuce in a part not previously affected was perceived. The patient stated that he had never before had any thing of the kind. Two years previously he had a trifling excoriation, which healed in a week; and two or three years before this again he had some similar affection, which may have taken three weeks to heal. Neither of these diseases was accompanied by any induration of the part affected, nor followed by any secondary symptoms.

The character of the secretion of a chancre often affords a most useful means of diagnosis. Like other signs, it may, however, be interfered with by accidental circumstances. The natural secretion from a primary infecting sore is serum, lymph, and epithelial scales. Any irritation applied to a denuded surface will cause a change in the nature of the secretion; and infecting sores, naturally characterised by the specific adhesive inflammation, offer no exception to this general rule. When irritated by caustic, they will suppurate. Irritating secretions applied to them will produce the same effect. The contact of coarse linen, or the confinement of the discharge by a scab, will have the same tendency. But if the sore be dressed with wet lint, in any of these cases, for three or four days, the secretion will assume its natural character. The circumstance most likely to interfere with the diagnosis of the character of the secretion from an infecting sore is, the inflammation of neighbouring portions of mucous membranes, or the contact of discharges from other parts. These may not only be mistaken for the secretions from the sore, but they may so far irritate it as to alter its character. A primary infecting sore, which naturally would present the character of the adhesive inflammation only, may for a time be covered by a puriform fluid, and its real nature may be so far temporarily masked. There are perhaps comparatively few primary sores, even of the infecting kind, which at some period of their duration, either from the original contact of irritating fluids, from the application of caustic as a mode of treatment, or from the irritation of accidental causes, do not secrete a puriform fluid. If these sores be allowed to assume their natural condition, in the way above mentioned, their real nature will be indicated by the character of the discharge. The infecting sore above described will always present the characters of the adhesive inflammation only during a very considerable period of its existence; and it will almost invariably leave, after all fluid secretion has ceased, a chronic indolent thickening, caused by the infiltration of the tissues with adhesive lymph.

Inoculation, as a rule, is of *no* value in determining the nature of a primary infecting sore. In the year 1856 I pointed out, as before mentioned, that primary infecting sores did not ordinarily yield a secretion capable of being inoculated upon patients upon whom the disease had already developed itself. Up to this time the infecting sores and the non-infecting were supposed to be alike inoculable. Dr. Sperino's work abounds with instances in which so-called indurated sores were inoculated upon the patients possessing them. Further experience, however, proves that these were not sores affected with the specific adhesive inflammation. They were suppurating sores followed by some amount of induration, such as not unfrequently accompanies suppurative inflammation.

In the year 1857 the inoculability of the secretion from sores affected with the specific adhesive inflammation was further put to the test in Paris.* It was then found that out of one hundred instances of indurated chancre, in one case only did the inoculation succeed upon the patient who had the disease.

The only opportunity we have of observing the direct effects of artificial inoculation, in producing the adhesive form of inflammation, is in patients who have already had either infecting sores or constitutional syphilis; since the circumstances would very rarely arise in which a surgeon would be justified in inoculating the matter from an infecting sore upon a patient who had not been previously infected.

The results of artificial inoculation, when it does succeed, upon those who have previously had the disease, will vary according to the date of the disease, and according to the degree of irritation present in the sore from which the inoculated matter has been taken.

Case II. A medical student having become diseased for the first time, inoculated himself on the thigh, and presented himself to me a very few days afterwards. The original sore was then surrounded by a circular, hard, button-shaped induration, and yielded very little secretion from its surface. The inoculation was at first a red pimple, containing a point of white lymph in its centre, but it soon assumed all the characters of the original sore. In this case the inoculation was performed almost as soon as the disease had manifested itself.

From this instance it is evident that a sore affected with the specific adhesive inflammation will yield a secretion capable of being inoculated during its earliest stage, before its specific action upon the patient's constitution has been developed, and that the result of that inoculation may be a specific hardened sore accurately resembling the original.

As soon as the specific adhesive inflammation has once taken place in a patient, his system is no longer in the same condition as before; he is no longer capable of being inoculated in the same way, and the inoculation, if attempted, in the vast majority of instances entirely fails.

But although the product of the specific adhesive inflammation, when fully established, is not, as a rule, capable of being again inoculated with the lancet upon the system which has produced it, yet both experiment and observation concur in proving that it may be so modified by certain actions as to become again inoculable upon the same individual. Under these conditions, however, the inoculations are uncertain in their results, producing very little local irritation, and capable of being transmitted by successive inoculations a comparatively very small number of times.*

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* *Leçons sur le Chancre,* p. 263.

If the indurated chancre from which the secretion is taken be irritable, a corresponding amount of irritability may show itself in the inoculations; and if the constitutional results of the specific adhesive action have previously been produced in the inoculated individual, specific induration will not take place. The results of the inoculation will then be either a pimple or a vesicle containing fluid more or less turbid, or a small circular red patch of skin over which the cuticle becomes thickened and exfoliated. No ulceration follows these inoculations, but the stain produced by them may last for weeks or months.

Case III. H. C. came under my care at the Lock Hospital on the 2d of February 1854. She had a syphilitic eruption upon the skin, and several irritable sores on the inner margins of the labia and perinæum. The inguinal glands were enlarged and indurated.

February 4th. Several spots were inoculated from angry-looking sores on the margin of the anus and labia.

6th. Several fresh inoculations were performed from other irritable sores.

11th. Each point inoculated had produced a kind of pustule. Fresh inoculations were made with the secretion of the original sores and with that of the artificial inoculations.

13th. Upon each point last inoculated a vesicle had appeared.

14th. The secretion of each vesicle had become turbid.

16th. Fresh inoculations were performed from the sores, natural and artificial, which furnished the largest amount of secretion. Eighteen hours afterwards the inoculated spots were found to be slightly reddened.

18th. Forty-four hours after the last inoculations, no result was perceptible. Several fresh spots were inoculated with the secretion of the sores near the anus, and with that of the sores artificially produced.

22d. The last inoculations had produced no effect. The inoculations of the 11th were forming small dry scabs. The eruption has now faded.

24th. Several spots were inoculated with as much secretion as could be obtained from any of the sores.

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* For cases see a paper by the author on *Different Forms of Primary Syphilitic Inoculation*, in the forty-second volume of the *Medico-Chirurgical Transactions*, for the year 1859.

27th. The inoculations last made had produced no effect.

March 2d. The sores, natural and artificial, had all healed. The patient was discharged as cured, having been under treatment exactly four weeks, and having apparently, during the last two weeks, not been susceptible of any further inoculation by means of the secretion derived from her own sores.

Case IV. A lad was admitted into the Lock Hospital on the 29th of July 1858. He had had gonorrhœa six months previously, but otherwise had been free from any venereal affection until about a fortnight before his admission. He then had a superficial sore behind the corona glandis, which healed in a few days. Two or three days after the first appearance of this sore, a little pimple appeared on the outer skin of the prepuce. This, on the 26th of July, presented all the appearances of a well-marked Hunterian chancre. It discharged from its surface a white turbid secretion. To a portion of this a drop of acetic acid was added; and it was examined by the microscope, and found to contain no pus-globules.

July 27th. The secretion was inoculated in several points on the patient's thigh.

29th. This was the day the patient was admitted into the hospital. The secretion from the sore was again examined, and found to contain no pus.

31st. Several fresh inoculations were made. The sore continued to increase in size.

August 3d. None of the inoculations had succeeded. The glands at the back of the neck were now enlarged, and the skin presented an incipient syphilitic eruption. A small blister was applied to the surface of the sore.

5th. A superficial slough had formed on the surface of the sore, which yielded in parts a puriform secretion. This was inoculated upon the thigh in several points.

7th. The sore now again secreted no pus. Fresh inoculations were performed.

10th. The sore was dressed twice yesterday with the sabine ointment, and now yielded a copious secretion of pus. This purulent secretion was inoculated in several points on a different part of the thigh.

12th. The inoculations last made had succeeded. The sore still yielded a copious secretion of pus.

14th. The inoculations both of the 5th and 10th had now succeeded, but not those of the 7th. They presented the appearance of circular red patches, with some elevation and thickening of the cuticle. In one place there was the appearance of a vesicle, from which a serous fluid exuded. This fluid was again inoculated upon the patient's thigh. The original sore, which had been dressed with water, now again yielded no pus.

17th. The inoculation from the inoculation had succeeded. It presented the appearance of a red circular patch, with slight thickening of the skin, from which the cuticle was abraded. It had not in the least assumed the appearance of a pustule, nor was any thing like pus secreted from its surface. A single pustule, surrounded by very little inflammation had, however, formed in one of the points first inoculated.

19th. The inoculations appeared as separate red patches on the skin, which, in these situations, was slightly raised and thickened, but no induration extended into its substance. The solitary pustule which appeared had dried up.

24th. One of the inoculations first made had a slight tendency to ulcerate; the others were desquamating and losing their colour.

Case V. Bridget C., æt. seventeen, was admitted into the Lock Hospital on the 26th of August 1858. She had suffered from a thick yellow discharge between two and three months. This was followed, in the course of as many weeks, by the appearance of two small places on the upper part of the left thigh. These, upon her admission, presented all the characters of well-marked primary indurated chancres in a state of progress. The surfaces of these sores were covered by a scanty tenacious secretion, in small quantity, which, upon microscopic examination, appeared to contain no pus. This secretion was carefully inoculated upon the patient's thigh.

August 28th. The inoculation was repeated. There was at this time no indication of the sores having any tendency to heal.

31st. No result from the inoculations. The two sores had now been dressed for two days with the unguentum sabinæ, and yielded an abundant secretion, distinctly purulent. The secretion from each sore was inoculated in several points close together in two separate places in the thigh.

September 2d. The inoculations last made have produced the appearance of small incipient pustules in both situations. The secretion from one of these was inoculated in two or three points on the thigh lower down.

4th. The inoculations from the inoculations had apparently succeeded. One of the inoculations of the 31st of August had produced a small pustule. The others had produced only vesicles. The skin over one of these was broken.

9th. The inoculations from the inoculations, performed on the

2d of September, have dried up. The inoculations first in order of the 31st of August had entirely lost their puriform character. They now appeared as circular patches, yielding a serous secretion, mixed with epithelial scales. The original chancres were now in process of healing.

11th. The inoculations first in order were desquamating, and of a light-red colour. The inoculations from the inoculations appeared as small red pimples, which were gradually losing their colour.

17th. The original chancres were cicatrised. The inoculations were fading and desquamating.

23d. The inoculations from the inoculations were still visible, and appeared as shining scales of discoloured epithelium.

25th. A few faint secondary spots appeared on the body. The original sores were quite healed, leaving slight induration. The corresponding glands in the groin were still enlarged and hard.

October 4th. This patient now left the hospital, but again presented herself on the 8th of October. The inoculations appeared as brown spots, the colour of which gradually faded into that of the surrounding skin.

It is quite possible that the persistence of the inoculations and their peculiar colour in the two last-recited cases may have depended upon the syphilitic diathesis of the patients. But this in no way militates against the fact, that inoculations succeeded at one time, while they failed at another, under precisely the same conditions of the general system.

In Case III. the inoculations succeeded so long only as the sores furnishing the secretion maintained their irritable character, and failed as soon as this irritability subsided.

In Cases IV. and V. the sores, the natural secretion of which could not be inoculated with the lancet upon the patient, furnished an inoculable secretion when artificially irritated.

In all the inoculations above recorded the effects appear to have been in direct relation to the amount of irritation present, and generally in proportion to the puriform condition of the secretion inoculated. It might be supposed, that in Case III. the sores ceased to be inoculable because they were in a healing condition; but this would not account for the inoculations produced from them ceasing to afford an inoculable secretion within four or five days of their first appearance. The inoculation, then, of the secretion of a sore affected with specific adhesive inflammation may take place, but is not easily performed, when once the patient's system has been affected with syphilis. When successful, the results are very different from those which follow the inoculation of the secretion from naturally suppurating sores. In the latter case each puncture produces a pustule, which, by repeated inoculation, will produce its like a great number of times. In the former, the inoculation as a rule fails, and succeeds only under circumstances of accidental irritation. It then can be repeated a very limited number of times, and the results obtained, even by a number of punctures in one situation, are comparatively of a trifling description.

There is, however, reason to believe that these same inoculations, if practised upon a patient whose system was not already affected with syphilis, would give rise to well-developed primary infecting sores.

It is, then, clearly shown that the primary form of the disease, which may be readily inoculated at first, after the lapse of a short time loses in a great measure its inoculability upon the patient himself, although by artificial means this is capable of being called into fresh activity for a certain period.

Secondary syphilis is not inoculable by the lancet upon the patient himself, nor upon another patient in the same condition. It is not, as compared with primary syphilis, readily conveyed to a person who has never had the disease, yet it is sufficiently often thus communicated. In one case which fell under my observation some years ago, a child with secondary symptoms infected its own grandmother, sixty-six years of age. The affection appeared in the form of a well-marked indurated chancre of the lip, which ulcerated extensively so soon as the consequent secondary eruption made its appearance. In a second case, a person who had been married some months had a well-marked specific induration upon the prepuce soon after his wife had become pregnant. The wife had previously been under my care for secondary symptoms; and it was ascertained, after the husband showed symptoms of disease, that she had an abrasion or ulceration of the neck of the uterus. Neither husband nor wife, in this case, had been exposed to any fresh contagion between the time of their marriage and the appearance of the disease. The affection in the man presented itself as an induration of the prepuce, which was cracked down to its centre; but which, independently of this, presented no ulceration whatever. A smart course of mercury was immediately prescribed; but, in spite of this, some faint secondary spots appeared upon his forehead.

Cases not unfrequently present themselves in practice, where there has been no exposure to contagion for about a month previous to the appearance of the disease; a pimple or a slight abrasion will then manifest itself, which will become surrounded by induration, and gradually present all the characters of a primary infecting sore. Or a patient will have a viscid tenacious discharge soon after exposure, which will continue three or four weeks, when it will suddenly cease, and be followed in some other part by a specific induration; and this in its turn will be followed by constitutional syphilis. Or a slight abrasion or ulceration may appear, which is often regarded both by patient and surgeon as of no consequence, but which at the end of three or four weeks alters its character, and assumes the form of an infecting sore, attended with specific adhesive inflammation. In all these cases there is a remarkable period of incubation, after which the real nature of the disease develops itself, and the glands in the groin become specifically enlarged, but not inflamed, presenting the same characters as in cases of primary syphilis arising immediately after exposure.

I have long suspected that cases presenting this long period of incubation have often been derived from secondary syphilitic affections. It is extremely difficult after the lapse of a month to trace the origin of the complaint; but from the great similarity which obtains between cases where the history is conclusive on the point and those where it is not, it may not be unreasonable to suppose that a fair proportion belong to the class of secondary syphilitic inoculations. From whichever source derived, the disease is identical in its physical appearance and runs the same course. It does not necessarily ulcerate; it does not, except from some accidental cause, suppurate; a loss of substance generally takes place by a kind of molecular necrosis.* The cells of epithelium and of the deeper tissues first show great increase of activity, and are subsequently thrown off in a thin ichorous discharge, while the increased action is transferred to a deeper layer, which in its turn is thrown off in the same way; a greater or less loss of substance thus occurs. The sore now remains in a sluggish indolent condition, casting off from its surface, from time to time, the cells which have been developed by the excess of activity of the adhesive inflammation. After four or five weeks the induration contracts, and in its contraction it fills up any excavation that may have been formed. The diminished induration may then remain, undergoing little change for four or five months, and sometimes for a much longer period. It is, however, very likely to break out again at the time of the appearance of secondary symptoms, which happens as a rule within six months of the original infection. The course of a chancre attended with the specific adhesive inflammation is marked by a sluggish indolent action. It commences in a slow and insidious manner, and is often unattended with pain. It generally exists alone, though occasionally several indurated sores present themselves at the same time. When this is the case, it will be found that they have all commenced about the same period; for, as we have seen, when once the specific adhesive inflammation has been established, the product of that inflammation will not renew the same action in the same individual. In this respect the inoculation of this disease is analogous to vaccination. It also resembles vaccination in the kind of inflammation which it produces, and the consequent effusion of lymph. In both cases the effusion extends on all sides of the inoculated point. But there is this peculiarity caused by the specific adhesive inflammation of syphilis, viz. that it terminates quite abruptly, and thus gives rise to the peculiar induration which characterises the infecting syphilitic sore. The natural tissues around this induration, unless accidentally inflamed, maintain their usual consistency and pliability. Nothing peculiar has been discovered with regard to the intimate nature of this induration. It appears essentially to consist in increased cell-development in the natural tissues and the normal products of the adhesive inflammation. The physical characters of the primary and secondary syphilitic inoculation are therefore, as far as observation has hitherto gone, identical.*

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* These observations apply equally to the primary and to the secondary forms of syphilitic inoculation.

It will occasionally happen that the infected part will be the seat of some accidental inflammation, and the effusion to which it gives rise will completely mask the specific induration. The character of the secretion from the surface of the chancre may also be so completely altered as to furnish no indication of its real nature. Under these circumstances it is necessary to wait until the ordinary inflammation has subsided, when the characteristic indications of the infecting chancre will remain.

The application of caustic is the most common means by which the true induration of an infecting chancre may be either simulated or masked: on the one hand, the induration produced by the application of caustic may very much resemble that of a primary infection, and on the other, the secretion of the part may by its means be rendered puriform; the former action may give to a simple sore the appearance of an infecting chancre, the latter may give to the infecting chancre the characters of a suppurating non-infecting sore.

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* For further information on the subject of secondary syphilitic inoculation, see a paper by the author, illustrated with coloured drawings, in vol. xliii. of the *Medical and Chirurgical Transactions.*

Another source of error arises from the application of more than one diseased secretion to the same part. This may take place either at the same or at different times. A part affected with specific adhesive inflammation may from this cause be made to suppurate for a longer or a shorter period; or a part to which two irritants have been applied at the same time may take on the specific action of each in succession. It is not very uncommon in practice to see a suppurating sore continue for three or four weeks, when the suppuration will cease and the part will become specifically indurated, and the patient will have secondary symptoms. The probable explanation of this circumstance is, that the specific adhesive form of inflammation in these cases has a natural period of incubation, during which any other action may take place. The irritating secretions from local syphilitic and other affections may thus produce their immediate effect upon the same part that afterwards becomes the seat of the specific infecting disease.

Indolent Bubo.

Sufficient reasons have already been given (p. 391) for supposing that the lymphatic vessels are not the usual channels through which the syphilitic poison enters a patient's constitution. The absorbent glands are, however, so intimately connected with the nutrition of the parts from whence their vessels are derived, that any diseased action in the one is readily communicated to the other. Such a diseased action is, however, transferred to those glands only into which the absorbent vessels directly enter; the vessels which proceed from these to other glands show no signs of disease, nor are the glands second in order affected. The diseased action may be traced as far as the first set of vessels, but no further: thus, in the case of a chancre upon the finger, the absorbent gland on the inside of the biceps muscle, above the elbow-joint, is commonly affected; and when this occurs, there will usually be no disease of the glands in the axilla. When the glands in the groin are affected, as is so often the case, the lymphatic vessels within the abdomen rarely if ever become diseased in consequence.

The action which takes place in an absorbent gland, in consequence of disease elsewhere, is commonly of the same nature as that disease. When the action, described in the previous pages under the name of specific adhesive inflammation, occurs in a part, the absorbent glands which receive the lymphatics from that part will become similarly affected. Thus, within a week or two of the appearance of the characteristic marks of an infecting chancre, the corresponding glands will become the seat of the same kind of action. One gland only may be affected, but in general there are more, situated just below the fold of the groin. The disease in them consists at first of a simple glandular enlargement, producing no pain, and often unperceived by the patient. The swelling produced is peculiar. It is limited exactly to the outline of the gland, and does not involve any surrounding structure. The induration here is as strictly defined as in the indurated chancre. Each gland may be felt, the size and shape of an almond-shell, as a foreign body under the skin. It slowly enlarges without any sign of surrounding inflammation. Except from accidental circumstances, the skin over it does not become red; it may be freely rolled over the gland, with which it forms no adhesion. These glands are not painful on pressure, and give the patient no inconvenience. They remain in a chronic indolent state of enlargement as long as the induration lingers about the original sore, and sometimes for months or years after the primary sore has healed. They do not suppurate as the result of the primary infecting sores which produce them; but having become enlarged, they are more liable than other glands to inflame from any accidental cause of irritation, and then they suppurate like glands in other parts. Thus, it will frequently happen that a gland will remain in a state of chronic indolent enlargement during the progress of a primary chancre; but as soon as a secondary eruption begins to appear, it will become inflamed, and suppurate. Here it is evidently the irritation of the secondary disease which produces the increased action. The gland will suppurate as a part of the secondary symptoms. Enlarged glands resulting from specific adhesive inflammation, whether they ultimately suppurate or not, do not contain any matter capable of being inoculated upon the patient himself; whether any fluid derived from them, and inoculated upon a patient who had not had an indurated sore or constitutional syphilis, would produce the disease, we have as yet no means of saying.

Case VI. A patient applied to me on the 17th of October 1853, with a large circular and indurated ulcer on the finger. It had existed, he stated, for four months, and was considerably larger than a shilling. Some well-marked syphilitic spots were appearing on his forehead and shoulders. He had never before had any similar disease, and had contracted his present affection, having exposed himself to contagion, after having burnt his finger with some quick lime. On the arm, above the elbow, and immediately on the inside of the biceps muscle, was an enlarged gland, over which the skin could be moved freely. There was a second smaller gland in the axilla. In front of the biceps were two very small rounded masses, probably enlarged lymphatic vessels. On the 19th of October, a fine needle was introduced nearly through the largest gland on the inside of the arm. Had the gland contained any inoculable fluid, we must suppose that some of this would have been let out, and that it would have contaminated the surrounding parts. The patient was now admitted into King's College Hospital. On the 21st, two days after the puncture, no result had appeared from the experiment; and on the 24th there was still no result, nor has any appeared since that time.

In cases where indolent buboes accompanying infecting sores have suppurated, either from some accidental cause or upon the appearance of secondary symptoms, the pus which has been produced has been inoculated in a great number of cases upon the patients who had the disease, but without producing any specific effect. A great contrast will appear in this respect between the chronic indolent bubo following the adhesive inflammation when from any accidental cause it does suppurate, and the bubo which immediately follows the naturally suppurating syphilitic sore.

The specific indolent bubo is essentially a chronic disease. It remains often long after the induration of the primary sore has disappeared, and it not unfrequently offers the only evidence of the remains of virus in the system. The chronic indolent bubo has been said invariably to accompany the infecting sore. This does not coincide with the author's experience. It no doubt does exist in the vast majority of instances, and when present furnishes a most valuable diagnostic symptom. In regarding this symptom as a means of diagnosis, we must bear in mind that as the induration of an infecting sore may be simulated in consequence of the application of caustic and other irritants, so may the glands in the groin for a time be made to enlarge from the same cause. The specific enlargement may, however, be generally distinguished from that produced by ordinary irritation, by the very abrupt and peculiar termination of the induration at the circumference of the glands, and by its persistent character.

Glands specifically enlarged are more subject than other glands to any accidental diseases, in the same way as a part once irritated is more liable than another to any accidental attack of inflammation. So long as they continue to perform their offices in the body, some of the old materials which have gone through their stages of growth and decay must find their passage to the centre of the circulation through these glands, already in a state of chronic enlargement and disease. Such refuse elements may be mixed with acrid or irritating matters, which, coming in contact with the enlarged glands, may cause them to inflame or perhaps to suppurate; or, again, in scrofulous subjects the imperfect nutrition of a part may be followed by a corresponding faulty action in some of the processes of decay, and an imperfectly converted material may be taken to glands already altered in their natural actions. This ill-prepared material arrived at a gland changed in its structure, cannot there undergo that digestion which is to fit it for being again received into the general circulation; an irritation ensues, which may be followed by inflammation, general thickening around the gland, or suppuration. In any such case the accidental cause of the inflammation forms no essential part of the original disease. The inflammation and suppuration are not of a specific character, and the pus discharged cannot produce any syphilitic disease by contact. The effects are in part those of ordinary inflammation superinduced upon the specific action.

Although the specific action in primary syphilis does not extend beyond the first series of lymphatic glands, yet it may produce its peculiar effects upon the lymphatic vessels situated between those glands and the original source of infection. The disease is here characterised by the same peculiarities as in the original chancre or in the specific bubo. A circumscribed round induration may be felt in the course of a lymphatic vessel, or a portion of the vessel may be converted into a hard knotted cord, giving the same sensation to the fingers as the vas deferens. In either case the induration is accurately circumscribed, and does not extend to surrounding parts.

Local Treatment of Primary Specific Inflammation.

Regarding the primary adhesive inflammation as the portal through which the syphilitic disease enters a patient's constitution, the first question which naturally arises is, whether the poison may not be destroyed in embryo by caustic, while the disease is as yet local. The writings of many authors would lead to the belief that this might generally be accomplished, provided the patients came sufficiently early under observation. If the results of the application of the syphilitic poison were always immediately developed, and if the affection produced by it always ran a definite course, terminating as has been so often described in the specific pustule, nothing would appear more easy and simple than at once to destroy the disease. But it has already been shown (p. 388) that the description of the development of the suppurating sore does not apply to the infecting chancre; a period of incubation may here exist lasting over days or weeks, and during this time there is no means of knowing what part will ultimately be proved to have received the poison. There is, therefore, in such a case, no possible means of judging where the caustic should be applied. At the end of this period, if the caustic be applied immediately the disease appears, it will not prevent its progress. The poison has lain dormant for a certain period, and has been imbibed by the surrounding tissues. The destruction of a small portion of these will not prevent the development of the morbid action in the remainder. In cases, however, where the results of syphilitic inoculation have appeared shortly after the application of the poison, the application of caustic furnishes a most efficient remedy against the further progress of the disease. The destruction of the tissue involves that of the poison which it contains. The experience of Sigmund of Vienna coincides with that of Ricord and other observers in establishing the fact, that if a part to which the syphilitic virus has been applied be destroyed by caustic within the first four days, no constitutional symptoms will follow; but inasmuch as the characters of the infecting sore very seldom declare themselves within this period, the remedy is one which cannot be said to be generally applicable to these cases. Its consideration will therefore be deferred to the description of suppurating syphilitic sores, which, as a rule, immediately follow inoculation; and for which cauterisation within the time specified furnishes a most valuable remedy.

The indurated chancre does not in general produce much inconvenience, and were it not for its consequences, would require little attention. It is true, indeed, that an indurated sore will sometimes become intractable, and be followed by a troublesome ulceration; but this occurs in general only where the patient's system has been infected with the poison, and where the local symptoms are a part of the secondary disease. Secondary induration and secondary ulceration will be more fully considered under the head of Secondary Symptoms.

The object of treatment in the primary specific adhesive inflammation is to get rid of the induration; so long as this remains, the patient is never safe from its consequences.

Excision of an indurated part has sometimes been practised; but, as in the case of the application of caustic when the disease has declared itself, the remedy is too late. The cut edges of the wound always take on the specific action, but this induration is probably not so persistent as that of the part originally infected; so that, although there can be no reasonable expectation of cutting short the disease by this mode of treatment, the patients ultimately appear to do better than where the original adhesive inflammation is left to run its course.

The best local application is some form of mercury. The common mercurial ointment may be applied, spread upon lint; or calomel, combined with mucilage and lime-water, may be used in the form of a lotion; or the surface of the part may be dusted with calomel-powder.

In cases where it is an object to cure a primary ulceration quickly, perhaps the best application is calomel fumigation locally applied. As this remedy is efficacious in various other forms of syphilitic disease, its mode of application will be described separately (p. 421).

Constitutional Treatment of Specific Primary Syphilitic Inflammation.

After the venereal poison has once entered the circulation and become disseminated throughout the system, it becomes very desirable to neutralise its effects before any secondary eruptions shall appear. Various are the remedies which have been employed for this purpose. Indeed, the variety of plans which have from time to time been recommended for the prevention of the occurrence of these secondary symptoms, and for curing them after they have appeared, includes almost all descriptions of medicine, local and general. Some surgeons have written works in order to prove that syphilis might be cured by sarsaparilla; others have advocated opium with equal earnestness. Again, whilst some have advised the use of ammonia, others have recommended the nitro-muriatic acid. In like manner guaiacum, china-root, mezereon-bark, hemlock, sassafras, juniper, saponaria, dulcamara, the green husk of the walnut, and many other vegetable and mineral products, have enjoyed a temporary reputation for the prevention and cure of syphilis. A few of these are certainly useful, in so far as they may assist in alleviating or removing a prominent or painful symptom; but the majority are of no sort of value as an antidote to, or a destroyer of, the syphilitic virus.

Of late years the iodide of potassium has been in great repute, and in certain secondary forms of the disease has proved a most valuable acquisition. With this exception, all the drugs mentioned have been in turn extolled, have fallen into comparative disuse, and afterwards have only occasionally been employed. A slight inquiry into the facts detailed by these numerous observers may in some measure acquaint us with the causes of the reputed success of the medicines which they severally advocated. It has been already observed, and will be fully proved in this and succeeding chapters, that there are varieties of syphilis: a syphilis which, if allowed to run its course, will affect the constitution and produce a well-marked action upon the whole system; and a syphilis which is a local disease, and however long it may remain without treatment, will never (unless it changes its peculiar character and assumes that known to be diagnostic of constitutional disease) be followed by other than local symptoms. What, then, it may be asked, was the syphilis treated by the drugs above mentioned, and which was said to be cured by them? What was the kind of affection? Were the cases instances of infecting or of non-infecting variety of the disease? Unfortunately for the reputation of these medicines, there is no evidence presented to show whether any discrimination had been employed in the selection of cases, or in tabulating them for reference; but all are promiscuously arranged under a single head. We are therefore justified in the inference that a large proportion of the cases treated were instances of non-infecting sores—sores which would under no conditions be naturally followed by secondary disease. Under these circumstances, it is no wonder that the primary affections healed, and were not in a considerable proportion of cases attended by infection of the patients' constitutions. But let a given number of cases bearing the before-described diagnostic marks of infecting sores be treated exclusively by any of these remedies, and the author ventures to affirm that the result would be most unsatisfactory. In fact, we find that all the remedies alluded to, with the exception of the iodide of potassium, after having a temporary reputation, have fallen into comparative disuse.

The treatment by inoculation, as practised by some continental surgeons, has been already noticed.

There is one medicine alone, mercury, which, through good report and evil report, in spite of the strongest prejudices of some against its use, and the no less adverse influence of others who have employed it to an unjustifiable extent, has maintained its general reputation.

From within a short time of the recognition of syphilis as a specific disease to the present, mercury has been extensively employed in its treatment; and during the whole of that time the majority of surgeons have regarded it as the most efficacious of all known remedies. It must be admitted that mercury has been often injudiciously given, and that it consequently has done much harm.

It has, nevertheless, maintained its reputation, and it may be safely affirmed that general experience has proved that no remedy exists possessing so great a power to extinguish the venereal poison as mercury. The iodide of potassium, to which allusion has been already made, possesses in an eminent degree the power of removing some forms of secondary eruptions; but does not, according to my experience, either prevent the occurrence or the recurrence of the disease in the same way as mercury.

There are three different ways of administering mercury. It may be given internally, in pills or solution; it may be introduced into the system through the skin, in the form of ointment; or it may be employed as vapour, also applied to the skin.

It is not necessary for me at present to enumerate at any great length the various preparations of mercury which have been found useful for internal administration. But some of them, in consequence of their almost universal employment, must be briefly mentioned. Blue-pill is one of the most common forms. It is, however, uncertain in its action upon many patients, and thus not unfrequently produces a greater degree of salivation than is desirable. The same objection, too, applies to calomel, and in both cases the exhibition of the drug is attended by considerable purging and other disturbances of the nutritive functions. In consequence of this irritating action, the mercurial must be combined with opium, a circumstance by no means desirable in all cases. The corrosive sublimate is also occasionally employed in cases of primary syphilis, and for a time is more easily borne by the stomach; yet even this can seldom be persisted in for a length of time sufficient to cure the disease. Indeed, all these internal forms of mercurial administration are found to affect the constitution in such a way as to make it extremely distasteful for patients to continue the course for a proper and necessary time.

Mercury introduced into the stomach and intestines produces, as is well known, a powerful effect upon the liver. This doubtless depends upon the blood from these parts being directly conveyed through the vena portæ to that organ. Sir Ranald Martin, in his admirable work on the influence of tropical climates, observes, that mercury enters into intimate union with the elements of the blood, and that it must therefore modify its plasticity, and influence all the organic functions to which it is subservient (p. 267). The parts upon which this influence expends itself, when mercury is given internally, are the liver and intestines. Even robust and healthy persons can seldom bear any prolonged irritation of these organs with impunity; and in patients of relaxed enfeebled habits, any prolonged mercurial action which produces its primary and direct influence upon those parts is quite out of the question as a remedial measure.

Mercurial inunction is a very efficient way of using mercury; but it is dirty, laborious, and often little suited to the taste of those who require its aid. On this account, patients very frequently use the remedy with great irregularity, or even remit it altogether. It is, however, much less liable to produce griping and purging than when the drug is given internally, and the effect upon the constitution is not nearly so debilitating. When mercurial ointment is used, half a drachm or a drachm is rubbed into the inside of the thighs by the patient every night. This in winter is conveniently done before a fire. The ointment should be rubbed in until it disappears. This process will occupy about half an hour. The patient should wear some flannel drawers, and not wash the remains of the ointment off. The application of the ointment must be repeated every night until the gums become soft and slightly spongy; this is the best indication of the proper action of mercury upon the patient's system, and this action should be maintained by regulating the quantity of ointment used for six, seven, or eight weeks, according to circumstances. Many surgeons are in the habit of leaving off the mercury soon after the patient's gums are affected. According to the author's experience, this practice not only fails to cure the disease, but actually does harm. The patient's constitution is weakened to a certain extent, and the disease is not cured; but what is of more importance still is, that the secondary symptoms, when they do appear, are often of a worse and more intractable character than if no mercury had been given.

There are two principal objects in view in treating a case of syphilis; the first is to remove the symptom, and the second to cure the disease. Now a short course of mercury will often effect the former of these two objects, as will also in almost all secondary cases the iodide of potassium; but neither the short course of mercury nor the iodide of potassium will in general cure syphilis. The symptoms will, it is true, be removed, but they will return; and practically it is found extremely difficult to induce patients, particularly in the upper classes of society, to continue a course of mercurial inunction sufficiently long to prevent the occurrence or the return of secondary syphilis.

Of all the modes of treatment by mercury, none, according to the author's experience, removes the symptoms so readily as calomel fumigation; none is attended by so little mischief to the patient's constitution; and none is followed so seldom by a relapse. The mode of employing calomel fumigation, applicable alike to general and local syphilis, will be presently described.

Whatever form of administration be chosen, the system must be kept under the influence of the drug, not only till all the symptoms have been subdued and removed, but also, if possible, till all induration in the primary sore has disappeared.

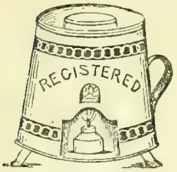
It is never necessary to produce salivation; and, indeed, with the plan recommended it is very difficult to do so. The determination to the skin, caused by the heat and moisture of the bath, has a tendency to prevent any excessive action upon internal parts. A slight tenderness of the gums, as an indication of the action of the mercury upon the system, is all that is required; but in cases where this particular proof of the action of the remedy is not present, it may influence the disease in an equally satisfactory way. The degree of action may be regulated with great nicety, either by increasing or diminishing the quantity of calomel used, or by regulating the time that the patient stays in the bath.

Mercurial Fumigation.

Since this method of employing mercury for the cure of syphilis is so general in its application, both as a means of obtaining a constitutional and a local effect, it has been thought convenient to describe it in a separate section.

The plan of fumigation itself is by no means new. It was used in Europe soon after the recognition of the venereal disease at the end of the fifteenth century; and it was subsequently very extensively practised in India and elsewhere. The cumbrous nature of the apparatus, however, and the want of precise knowledge of the nature of the substance employed, has, even up to the present time, prevented this mode of treatment from coming into general use. Recently, however, the plan of using mercurial fumigation has been much improved. We are indebted to Mr. Langston Parker for having much simplified the apparatus, which at various intervals was used by Lalonette, Pearson, Abernethy, and others. Many other surgeons have from time to time added improvements; and at present the best and simplest apparatus with which I am acquainted is that made at my request by Messrs. Savigny and Co. of St. James's Street. This has been completed, after many modifications, undertaken at the suggestion of Mr. Pollock of St. George's Hospital.

It consists of a kind of tin case, containing a spirit-lamp. In the centre, immediately over the wick of the lamp, is a small circular tin plate, upon which the mercurial powder is placed. Around this is a circular depression, which is half-filled with boiling-water. The patient places this on the ground, and sits over it or near it on a small cane stool. He is then enveloped, lamp and all, in a circular cloak, made expressly for this purpose by Messrs. Savigny. When a cloak cannot be procured, a double blanket answers the purpose very well. At the expiration of a quarter of an hour or twenty minutes, the calomel which is placed upon the lamp, the water, and the spirit will have disappeared, and the patient may then get into bed. The plan just described is very efficient; and similar instruments have been devised by other makers.



During the time the patient is taking the bath, he may inhale the vapour for half a minute or a minute on two or three different occasions with advantage; and after the bath is over, he must contrive not to wipe off the calomel deposited upon his skin. Patients are generally recommended to sit over the bath for two or three minutes after the lamp has gone out. They are then sufficiently cool to put their day or night shirt on, as the case may be, without disturbing the calomel on the surface of the skin. A portion of that which is there left becomes, by a slow process of imbibition, absorbed into the patient's system.

Amongst the poor a less expensive apparatus is convenient. Half a brick is directed to be heated to a dull red heat, and is then placed in a pan having a little water in the bottom. On the top of the heated brick the mercury is placed. The patient then sits over the pan (either on a cane stool or otherwise) for twenty minutes, with a large blanket, reaching down to the ground, round his neck. It will be noticed that in all these arrangements provision is made not only for the volatilisation of the mercury, but also for the presence of water in a state of vapour. This is important, for practically it is found that the mercurial action is more certainly produced and more steadily maintained when mixed with a certain quantity of vapour of water than in dry air.

Many preparations of mercury have been recommended by different surgeons. Mr. Parker recommends, that from one to three drachms of the bisulphuret of mercury, or the same quantity of gray oxide or the binoxide, should be used on each occasion. Now these preparations are occasionally attended by serious inconveniences and objections. The bisulphuret of mercury, when exposed to heat, gives off some vapour, probably sulphurous-acid gas, which causes much irritation when inhaled; and I have reason to believe that the symptoms produced by this preparation have been amongst the reasons why mercurial fumigation has not been more generally adopted. The gray oxide, again, is found to be of uncertain composition; and as obtained at the shops, it will often not volatilise at the temperature produced by an ordinary small spirit-lamp. When it does volatilise, it is decomposed. It is first converted, partially or entirely, into the deutoxide of mercury; and if the temperature is increased, the oxygen is given off, and finally metallic mercury is sublimed. The uncertainty of the composition of this preparation, both before and after it has been exposed to heat, naturally implies that its effects will be uncertain, and such in practice they will be found to be. Sometimes very little mercurial action has been produced, and occasionally the action has been excessive. The preparation which the author has for the last six years constantly used is calomel. It possesses the advantage of being easily sublimed at a temperature which may be commanded in any private house. It is not decomposed either by heat or by the vapour of water, and a comparatively small quantity is sufficient to produce all the effects required. As a general rule, from fifteen to twenty grains will be found sufficient, though occasionally it may be desirable to employ as much as thirty grains.

The following case illustrates very fairly the action of the calomel-bath, under circumstances where mercury administered internally would have been quite out of the question.

Case VII. A woman was admitted into King's College Hospital, and lay for months in St. Clement's ward unable to move out of bed or in bed. The surface of her body was covered with numerous extremely painful syphilitic ulcerations, and she suffered from a similar affection of the throat. In this case all the usual remedies were employed, but without benefit. She was at length sent for change of air into another hospital. The change certainly did her good for a time. The ulcerations showed a disposition to heal, and she gained some strength. She soon, however, relapsed; the ulcerations again spread, and she fell into much the same condition as before. She now began the calomel fumigations, according to the plan described, and with marked improvement. She soon became so well that she could with difficulty be restrained within due bounds, and ultimately the governors discharged her for misconduct before she was quite well.

Of all the modes of administering mercury, fumigation is attended with the least demand upon the power of the patient's constitution, and can be regulated with the greatest facility, and consequently can be maintained without inconvenience for almost any period. On this account, as well as for other reasons, it is less likely to be followed by a recurrence of secondary symptoms than any other mode of treatment whatever. And of all the methods of fumigation, that by calomel is the safest and most convenient, if not the most efficacious. The imbibition of the medicine through the skin prevents its injurious action upon internal parts; while the small quantity used, although quite sufficient to produce any amount of action that may be required, insures the patient against any sudden or violent effects.

Local calomel fumigation. Different kinds of apparatus have been used for local fumigation. The calomel fumigating lamp, previously described, answers the purpose extremely well. The vapour of calomel, being of very light specific gravity, ascends, and any part placed over it becomes coated with a very fine layer of calomel. This forms an excellent dressing for intractable ulcers, whether of a primary or secondary nature. Tubes of various shapes have also been employed so as to direct the vapour of the calomel to particular parts. Thus, a long tube has been adapted to the calomel-lamp with a mouthpiece, for the purpose of inhalation in affections of the throat. A roll of paper has been often used for the same object. But it is evident that, as the calomel mixes with the air, the simple act of respiration does all that is required; and as far as the throat is concerned, any tube is much more likely to detain the calomel than to direct its course. It is often, however, convenient to direct the vapour of calomel to parts which cannot well be brought over an ordinary lamp, and then an additional apparatus is necessary; one which has now for a long time been in use in the Lock Hospital consists of a curved earthenware tube open at one end, with a spirit-lamp applied at the other. Some calomel is placed within the tube, and when volatilised may conveniently be directed to any part.

Secondary Syphilis. Constitutional Infection.

When the syphilitic poison enters a patient's constitution, it produces a general, if not a permanent, impression. Like the vaccine virus, it influences the whole body so that it is with difficulty that the action by which the poison was introduced can be again produced in any part of the system. Inoculation, followed by the specific infecting action, which takes place readily enough (as shown by daily experience) in those whose constitutions have not before been infected, has now lost its power. If followed by any results, they are modified in a most material way. The character of the disease is completely altered. If any local disease is produced, it is insignificant, and followed as a rule by no general or constitutional results.

The presence of the syphilitic poison, when received for the first time into a patient's system, is usually marked by a certain amount of general disturbance. The patient feels feverish and uncomfortable; the skin becomes dry, and the tongue perhaps coated. It occasionally, however, happens that the secondary or constitutional symptoms show themselves without the patient feeling any general inconvenience.

Lassitude, weariness, and pain in different parts, frequently mark the progress of the disease. The skin loses its fresh and healthy colour, and assumes often a sallow hue. The blood has been supposed to be altered in syphilis, but the proofs of this are not at present satisfactory.

When the general system is thus affected by the syphilitic poison, it is probable that the nutrition of every part of the body may be thereby influenced. The same tendency to the separation of lymph from the other elements of blood may be manifest in any part of the body as in the original disease. These effusions are more or less organised, and take their characters from the structures in which they are formed. Thus, in the skin, or tongue, the papillæ become inordinately developed; and if several of these join together, tubercles are formed. On the iris, the lymph effused forms fibrous bands, which unite it to adjacent parts and prevent its actions. If the periosteum of a bone is affected, the effused material immediately becomes converted into new bone; and this process, from the unyielding nature of the parts, is attended with much pain, experienced chiefly at night (which has been supposed to be the period of growth). According to the constitution of the patient, the part affected may take on the adhesive, the suppurative, or the ulcerative form of inflammation; or any of these may terminate in gangrene, molecular or of the whole surface. Hence a syphilitic affection which commences as a pimple may at a subsequent period suppurate, or ulcerate, or a portion of its surface may be thrown off as a small slough. Different names have been given to these different forms of disease; but it is obvious that as long as they are liable to pass one into another, no very accurate divisions can be made. Again; a division has been made with regard to the time at which different parts of the animal economy are affected. The skin, the eye, and the mucous membranes are those in which the disease appears in the earlier stages of the complaint; and diseases of these parts have been called secondary symptoms, whereas the fibrous and osseous tissues and the deeper structures generally are, as a rule, affected later, and syphilitic diseases of these parts have been called tertiary symptoms. This distinction will be adopted for convenience of description, but it must not thence be inferred that there is any well-marked natural division; and, in fact, the so-called tertiary symptoms sometimes appear before the secondary, and the parts belonging to these respective classes are constantly found affected at the same time.

Secondary Symptoms.

The specific induration around the infecting sore has been regarded as the first of the secondary symptoms. This is, however, not attended with any of the constitutional symptoms above referred to. At an uncertain date, but generally from four to seven weeks from the first appearance of this induration, the syphilitic fever, often very slightly marked, will occur; and in a great majority of instances this will be followed by an exanthematous eruption of the skin, often accompanied by sore throat. At the time that this occurs, a change may often be observed in the character of the original sore; a fresh effusion of lymph may take place in its neighbourhood, or the sore itself may ulcerate in a way in which it did not before. The secretion from the surface of the sore will now become altered—a free secretion of pus will often take place from its surface. It no longer presents the characters of the adhesive inflammation only. It has, in fact, become one of the secondary symptoms of the disease. The inguinal glands, in like manner, which up to this period were indurated and enlarged only, will now sometimes show signs of increased morbid action. They may become tender to the touch. The thickening originally confined to the glands themselves may involve the surrounding cellular tissue; and it not unfrequently happens that an abscess will form either in one of the glands themselves or in the surrounding structure. These suppurating buboes are to be regarded as a part of the secondary symptoms; and their occurrence in no way invalidates the proposition before laid down, and which will be more fully dwelt upon in the section upon local syphilitic ulceration, viz. that the sores which produce syphilitic infection of the constitution do not produce suppurating buboes, excepting from some such accidental cause as the one now referred to.

Syphilitic Eruptions.

Roseola, the eruption which generally first succeeds the syphilitic fever, is of a rose-red colour, not raised above the surface of the skin; disappearing upon pressure, and returning as soon as the pressure is removed. It appears in more or less rounded patches, giving a mottled appearance to the skin; when examined closely, each patch appears made up of a cluster of papillæ, more injected than natural. This eruption will sometimes disappear within a few days. If it persists, the papillæ forming each patch will generally become visibly enlarged, and the colour of the eruption will gradually change to a copper-colour. This colour is a common characteristic of all syphilitic eruptions which remain for any length of time without suppuration or ulceration.

The syphilitic eruptions which follow this first efflorescence on the skin present a variety of appearances.

Lichen. The papillæ of the skin frequently are enlarged separately and scattered irregularly over the body. They form small hard elevations of a copper-colour, which terminate by desquamation or resolution. The enlarged papillæ are sometimes formed into groups, and then, occasionally, one much larger than the rest appears as a tubercle in the centre. This form of eruption has been described separately as *central tubercle.*

Syphilitic tubercle. The same tendency which has been traced throughout to the exudation of a fibrinous and albuminous material from the diseased blood manifests itself particularly in this form of disease. The effusion takes place by a slow, gradual, and uninterrupted process, and becomes perfectly organised as in the papular eruption; each tubercle appears as a small, full, and tense conical eminence, covered with a red and shining cuticle, and gradually, like other syphilitic eruptions, assuming a copper-colour. The tubercles may be scattered singly over the surface, or they may be seen in groups.

The syphilitic tubercle may assume any size from a large pimple to a split pea or bean. Their shape is generally round, but often they are irregularly oval. The epithelium thrown off from the surface of syphilitic tubercles on the skin is peculiarly thin, white, and shining. It resembles small broken pieces of silver-paper. When syphilitic tubercles appear on mucous membranes, they are generally irregular in shape, flattened, and but slightly raised above the surface. These peculiarities depend in a great measure upon the mucous membrane from which they spring being opposed to other parts, and consequently exposed to a certain amount of pressure. The tubercular form of eruption on the skin generally occurs at a later period than the other eruptions, accompanied by the adhesive form of inflammation.

Syphilitic lepra commences like the mottled skin previously described by the injection of circular groups of the papillæ of the skin. These may at first be seen separate, but soon the whole circular patch becomes equally involved; an effusion takes place into the substance of the skin, which causes a small flat elevation, the edges of which are sometimes raised higher than the centre. A large number of these patches, all perfectly circular, may form on any part of the body. They have, like other syphilitic eruptions, more or less of a copper-colour, but this is often partially masked by a thin layer of epithelium, which is thrown off in thin white and shining scales. Patches of syphilitic lepra sometimes bear a strong resemblance to flattened syphilitic tubercles.

Syphilitic psoriasis occurs in the form of oval or irregular patches slightly raised above the surface. These are generally of a brown or copper colour, and covered with epithelial scales of various degrees of thickness. They are not depressed in the centre, and are often traversed by cracks which show no tendency to become obliterated. This disease is much more persistent in its character than syphilitic lepra. It is frequently observed on the palms of the hands and soles of the feet, but it may occur on any part of the body. Patches of syphilitic psoriasis will sometimes remain for months without undergoing much alteration in appearance.

The eruptions now described may be classed together as resulting from secondary adhesive inflammation; they are essentially of the same character, and require the same mode of treatment. Not unfrequently they will appear upon the same patient at the same time, or will follow each other at successive periods. The tendency of these, as of other syphilitic eruptions, is to fade after a time, but to appear again and again unless checked by treatment; after the disease has existed some time, they have, however, a greater tendency to assume an ulcerative or suppurative form than to recur in their proper adhesive character.

The same mode of treatment has been adopted generally for these eruptions as for the primary disease to which they owe their origin.

Mercury, in some form, is the remedy that alone can be relied upon. As in the primary infecting sore, it may be administered internally, or may be used in the form of ointment rubbed on the skin, or may be given as a mercurial vapour-bath.

In private practice it may be convenient to give mercury internally, on account of the little observation which this plan attracts and the apparent ease with which it is followed. But, even with young men in the vigour of health, it will rarely happen that mercury can be taken sufficiently long in this way to cure the disease: at the end of perhaps two or three weeks, the digestive organs become disturbed by the constant irritation of the medicine, an attack of diarrhœa perhaps supervenes, which may be checked for a time by opium; but if the internal administration of the mercury be continued, some other form of inconvenience will arise; and, practically, the remedy has to be given up, in the very great majority of cases, before the patient is cured. When the eruption occurs under these circumstances at a subsequent period, it presents often a more troublesome and worse form of disease than if no mercury had been given; the long-continued irritation of the patient's digestive organs has produced an effect upon his system, and the diseased as well as the healthy actions of the body consequently are performed with enfeebled powers, and a lower type of affections is produced. From these considerations, the use of mercury internally has for several years past been abandoned at the Lock Hospital, in the author's practice. The inunction of mercurial ointment is a very efficient way of bringing a patient's system under the influence of the drug; and the action may in this way be continued for the requisite length of time, provided the laborious process which it entails and the dirty condition in which it leaves the skin are not objected to. In the treatment of cases of eruption on the skin it may, however, cause irritation in any of the spots upon which the ointment is rubbed, and consequently have to be discontinued. The mercurial vapour-bath is by far the least disagreeable mode of administering mercury; at the same time that it enables the surgeon to regulate the action of the medicine with the greatest nicety, it does not endanger the patient's powers, nor produce irritation in any part of the surface.

The syphilitic disease has a natural tendency to produce its effects upon the skin. It is through this organ that nature appears to attempt to eliminate the poison, and any remedy applied directly to this part must have a much more direct influence upon the different forms of eruption which have been mentioned than when taken into the stomach. The combination of heat and moisture in the mercurial vapour-bath necessarily produces increased action of the vessels of the skin; and as eruptions here are far less injurious to a patient's constitution than internal syphilitic affections, the use of the mercurial bath assists in the most favourable and natural development of the disease. The increased action on the surface which it induces also prevents any excessive action of the mercury on the gums or other internal parts.

In cases of eruption on the skin, the remedy is applied in this way directly to the disease, and consequently a comparatively small quantity is required. In the general mercurial bath nearly the whole surface of the skin is employed for the purpose of absorption, and it is surprising how small a quantity of mercury will in this way produce the requisite effect.

Calomel, being changed in composition neither by heat nor moisture, is the preparation now most generally used. Fifteen or twenty grains of this may be used as recommended (p. 421) upon each occasion; of this quantity a very considerable proportion becomes dissipated in the room or deposited upon the cloak which surrounds the patient; and of the quantity which is brought in contact with the patient's skin a very small part again becomes absorbed into his system, so that the real amount of mercury which enters into combination with the living tissues of the body is very much less when administered in this way than when taken internally.

Iodide of potassium has very often been given for the papular, tubercular, and squamous syphilitic eruptions. From three to five grains are generally given in solution three times a day. This medicine certainly has a great power in removing syphilitic eruptions, and other forms of secondary and tertiary syphilis; but it does not, according to the author's experience, cure the disease. The symptoms disappear, the surgeon and the patient often congratulate themselves on the result, but within a few weeks the eruption appears again in the same, or in a somewhat different, form.

Iodide of mercury is a very favourite medicine with many continental surgeons; a grain may be made into a pill and given three times a day, and this dose may be gradually increased to three grains.

Mercury given in this form is more easily eliminated from the system than when given alone, and it also produces a more visible and decided effect upon the patient's system.

Iodide of potassium, or iodide of sodium, may be given internally, while the mercury is administered through the skin. These medicines probably then unite in the system, and produce much the same effect as if the iodide of mercury were given. This mode of giving the iodide of mercury has, however, the great advantage of saving the digestive organs and the liver from any irritation from the mercury.

Sarsaparilla, useful in some forms of tertiary syphilis, has very little, if any, influence over the eruptions under consideration. Mr. Blomfield, formerly surgeon to the Lock Hospital, in his practical observations, says: "I solemnly declare I never saw a single instance in my life where it cured the disorder without the assistance of mercury." Mr. Pearson's observations led him to the same conclusion. We are therefore induced to believe, although sarsaparilla is often given even at the present day for papular, tubercular, and scaly eruptions on the skin, that these affections, when they appear to have been benefited by that medicine, have in reality either in their natural course undergone a change for the better, or have been relieved by other medicines given at the same time.

"One source, and a very common one," observes Mr. Pearson, "to which some of the mistakes committed upon this subject may be traced, is a persuasion that every morbid alteration which arises in an infected person is actually tainted with the venereal virus, and ought to be ascribed to it as its real cause.

"Every experienced surgeon must, however, be aware that very little truth or reality exists in a representation of this kind. The contagious matter and the mineral specific may jointly produce in certain habits of body a new series of symptoms, which, strictly speaking, are not venereal, which cannot be cured by mercury, and which sometimes are more to be dreaded than the simple and natural effects of the venereal virus. Some of the most formidable of these appearances may be sometimes removed by sarsaparilla, the venereal virus still remaining in the system; and when the force of that poison has been completely subdued by mercury, the same vegetable is also capable of freeing the patient from what may be called the sequelæ of a mercurial course."

Pustular syphilitic eruption. When the syphilitic disease was first recognised at the end of the fifteenth century, the eruptions which it produced are frequently described as pustular. No very accurate description of these so-called pustules is, however, given; and, considering the vague nomenclature of the day, it appears more probable that eruptions should have been called pustular which were not so in reality, than that the disease should have so far changed its nature as to present in its normal development a different character at present than it then did. Pustular syphilitic eruptions do occur, but they are very rare in unimpaired constitutions, and as the first eruption consequent upon the primary disease.

From constitutional causes, the primary disease which, in its normal course and in a healthy constitution, would present the characters of the adhesive form of inflammation, may soon after its first appearance suppurate, become phagedænic, or, in a few exceptional cases, it may ulcerate specifically. So the secondary form of eruption, which, in a healthy person, would produce one of the eruptions characterised by the adhesive form of inflammation, may suppurate, ulcerate, or become phagedænic.

The most common form of pustular syphilitic eruption arises from the transformation of one of the forms of the adhesive into the suppurative inflammation. A papular or tubercular eruption will appear in the first instance, and the plastic material effused will be completely organised; the patient may then have an imperfect or irregular course of mercury, or his health may be deteriorated from other causes, and the eruption will then reappear, and the summit of each spot will contain a material in the shape of pus more or less perfectly formed, and which is incapable of being organised.

The proper syphilitic pustular eruptions are divided by Cazenave* into three kinds, which he describes as follows:

"1. In one form the pustules (*psydraceous*) are either small and narrow, or of a large size, elevated, and round. They have a hard base, and are surrounded by a copper-coloured areola. The pustules themselves are of a dull reddish hue, and are developed in successive crops, presenting examples of the disease in its origin, maturity, and decline. Their progress is slow, and the inflammation attending them moderate; in some cases, however, it destroys the true skin, and leaves behind it a small, white, circular scar, depressed in the centre, and not larger than a pin's head. These scars, which have been erroneously supposed to follow papules, because the affection has been confounded with a papular eruption, are in a great majority of cases the sequels of true pustules. This form chiefly occurs on the face and forehead, where it bears some resemblance to acne rosacea; but it may appear on every part of the surface. The pustules dry off, and form a small grayish scab, which separates, and may leave behind it either a cicatrix or some injection of the skin. The psydraceous pustules rarely terminate in ulceration, and then only when several of them have become confluent.

"When seated on the limbs, these pustules present a different appearance. They are sometimes of the size of a lentil, quite numerous and but slightly elevated above the surface, with a hard base, and contain a very small quantity of yellowish-white matter, which presents a strong contrast to the copper-coloured elevation on which it rests. They are not followed by ulcers; a thin scab forms on them, which is followed by a scar, or sometimes by a livid discoloration, or a small chronic induration.

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* *Manual of Diseases of the Skin*, by Burgess.

"2. *Syphilitic impetigo.* This form is usually preceded by slight malaise, and commences with redness of the affected points; this is followed by small collections of purulent matter, forming irregularly-shaped patches, more or less confluent, resting upon surfaces of a coppery-red colour, which are soon covered by scabs irregular in shape, harder, darker coloured, and more adherent than those of common impetigo. Beneath these scabs are characteristic ulcerations, which are followed by scars, varying in extent and shape. This is the form called *pustulo-crustaceous* syphilitic eruption. It may affect any part of the surface, but more frequently attacks the face. It sometimes appears on several places at the same time, but has no tendency to spread to neighbouring parts. It is always secondary.

"3. In the third variety of syphilitic pustular eruption, the pustules are still larger (*ecthyma syphiliticum*), and resemble those of ecthyma. They are few in number, isolated, and chiefly occur on the limbs, and especially the legs. They appear at first under the form of a large livid spot, about the size of a shilling, or larger. The epidermis is now raised over a considerable portion of the spot, by a grayish, sero-purulent matter; the elevation increases slowly, and is always surrounded by a broad copper-coloured areola, quite different from that of ordinary ecthyma, which is of a violet-red. After a few days, the pustule breaks, and the contained matter concretes into a dark hard scab, which gradually becomes thicker, and fissured at the edges, being of a circular shape. All this occurs without any local inflammation: there is little heat, and no pain; the scabs are extremely tenacious, and may remain for an indefinite time without separating. When they do come away, we find underneath them deep round ulcers, with sharp-cut hard edges, of a purple colour, whilst the bottom is grayish and ill-looking. They have little tendency to spread. The scabs now gradually form again, and are frequently renewed, until, under the use of appropriate means, they become thinner, while the ulcers get clean and heal, leaving behind them circular and lasting cicatrices.

"This is the most common form of the syphilitic pustular eruption, and the one which usually occurs in new-born children. Here the pustules are broad, superficial, flat, of an oval shape, and in great numbers; the scabs are dark and thick, and conceal small ulcers underneath. The countenance of the patient presents, at the same time, a peculiar appearance, which it is difficult to describe: the skin is of an earthy hue; the child is emaciated, the face is drawn in and marked, like that of an old person, by numerous wrinkles, while the whole body exhales a most disagreeable odour."

It is the secondary syphilitic ecthyma that M. Vidal has long maintained might be inoculated, so as to produce not only local but constitutional syphilitic disease.

Treatment of pustular syphilitic eruptions. It will, I believe, be found a universal rule in the treatment of both primary and secondary syphilis, that mercury will not agree with patients during the time that active suppuration, on however small a scale, is taking place. Other remedies have then to be sought; among these the iodide of potassium occupies the first place. This remedy may be given alone, or in combination with iron or other tonics. The usual dose is from three to five grains, three times a day, in solution. This medicine has a marked effect in removing the symptoms in almost every form of secondary syphilis, and practically this is a great advantage; but it certainly does not cure the disease in the same way as mercury does, when that medicine is properly administered, and can be conveniently borne.

Larger doses of the iodide of potassium are often given, as much as ten or fifteen grains three times a day; but it is doubtful whether these doses possess any advantage over the smaller ones.

Guaiacum in the form of decoction was supposed, during two centuries, to possess antivenereal properties; and we are told by Mr. Pearson that its reputation was supported by well-attested narratives in a great number of instances where no mercury had been employed, or where that medicine had done no permanent good, or where the patients had suffered injury from it instead of finding advantage.

After a careful investigation of the properties of guaiacum, the following are Mr. Pearson's conclusions with regard to it. "The decoction commonly excites a grateful sensation of warmth in the stomach; it gives a sense of dryness to the mouth, and creates thirst; it also increases the natural temperature of the skin, and renders the pulse more frequent. If the patient drink the decoction warm and lie in bed, it generally proves moderately sudorific; and this effect may be heightened as much as we please, by employing the hot bath, the vapour-bath, antimonials combined with opium, or the pulvis ipecacuanhæ compositus. When the decoction has been continued during ten or twelve days, in the quantity of four pints each day, the patient often complains of its producing the heartburn, accompanied with flatulence; and he is usually costive during the whole course. If the person expose himself freely to the air while he is taking this medicine, the secretion of urine will be augmented, but no sensible alteration will take place in the state of the skin.

"When I have exhibited the decoction of guaiacum in pains of the bones, as they are called, confining the patient at the same time to the bed, and enjoining a diet consisting of fluids only, I have rarely seen any beneficial consequences result from the use of it, except where it acted as a sudorific; and in this respect I think its qualities manifestly inferior to antimony or volatile alkali. In several instances, after persisting in a course of it during four or five weeks, I have not gained any material advantage; and I have remarked, that when the dolores osteocopi were not connected with some morbid alteration of the structure of a part, this medicine was of little avail. When the strength and vigour has been reduced by a successful mercurial course, with confinement to the house, and where a thickened state of the ligaments or of the periosteum remains, or where there are foul indolent ulcers, these sores will often heal, and the enlarged membranes will subside, during the administration of this decoction.

"The decoction of guaiacum will often suspend the progress of certain secondary symptoms of lues venerea for a short time, such as ulcers of the tonsils, venereal eruptions, and even nodes; but I never saw one single instance in which the powers of this medicine eradicated the venereal virus. It has been recommended by many people to combine guaiacum with mercury, with the intention of improving the specific powers, and of counteracting the injurious effects, of that mineral; the advantages to be derived from this compound mode of treatment are by no means well established, for guaiacum is certainly no antidote against syphilis."

Mr. Pearson's opinion with regard to the virtues of sarsaparilla, founded as it was upon a very large experience and a great number of experiments, is perhaps as valuable and correct as can be obtained. "While I reject it," he says, "as a specific, I would by no means disparage it as a medicine possessing no valuable qualities. In those cases where the malignant powers of the virus have proved materially prejudicial to the health, so that the patient cannot enter upon the use of mercury with propriety, the decoction and powder of sarsaparilla will often retard the destructive agency of the venereal poison, and repair the breaches made in the constitution: it may be sometimes given with advantage during a course of mercurial frictions, when it does not occasion a determination to the bowels; and it will almost invariably remove many of the most troublesome sequelæ of a course of mercury.

"Nor are the salutary properties of the sarsaparilla-root useful in those diseases only that are either immediately or remotely connected with syphilis; its beneficial effects are often demonstrated in the treatment of foul, untractable, spreading sores in more than one form of scrofula."

In all diseases characterised by want of power, bark may be advantageously employed; and it may often be most beneficially used in cases of syphilitic eruption, where, either from some constitutional peculiarity, or from the long continuance of the disease, or from the debilitating effects of the remedies employed, a want of power is manifested in a patient's system. It may conveniently be given during a mercurial course, or after the mercury has been discontinued. The beneficial effects of bark are, however, most manifest in cases where destructive ulceration or sloughing occur; and in describing these processes it will again be referred to.

Opium is, next to mercury and the iodide of potassium, perhaps the most useful remedy in the treatment of venereal diseases; and with regard to it Mr. Pearson's opinion may again be taken. He says: "An experience of nearly twenty years has taught me, that when it is combined with mercury, the proper efficacy of the latter is not in any measure increased; and that it would not be safe to rely upon a smaller quantity of the mineral specific, nor to contract the mercurial course within a shorter limit than where no opium has been employed.

"This representation will not, I presume, admit of controversy; yet we frequently hear people expressing themselves upon this head, as if opium manifested some peculiar qualities in venereal complaints of a distinct nature from its well-known narcotic properties, and thus afforded an important aid to mercury in the removal of lues venerea. Perhaps it may not be unuseful to disentangle this subject from the perplexity in which such indefinite language necessarily involves it.

"Opium, when given in conjunction with mercury, by diminishing the sensibility of the stomach and bowels, prevents many of those inconveniences which this mineral is apt to excite in the primæ viæ; and thus its admission into the general system is facilitated. Mercury will likewise often produce a morbid irritability, accompanied with restlessness and insomnolescence; and it sometimes renders venereal sores painful and disposed to spread. These accidental evils, not necessarily connected with the venereal disease, may be commonly alleviated, and often entirely removed, by a judicious administration of opium; and the patient will consequently be enabled to persist in using the mineral specific. It must, however, be perfectly obvious, that opium, in conferring this sort of relief, communicates no additional virtues to mercury; and that in reality it assists the constitution of the patient, not the operation of the medicine with which it is combined. The salutary effects of mercury as an antidote may be diminished, or lost, by the supervention of vomiting, dysentery, &c. Opium will often correct these morbid appearances, and so will spices, wine, an appropriate diet, &c.; yet it would be a strange use of words to urge, wherever these articles of food were beneficial to a venereal patient, that they concurred in augmenting the medicinal virtues of mercury. It may be supposed that the majority of medical men would understand by the terms, 'to assist a medicine in curing a contagious disease,' that the drug conjoined with the specific actually increased its medicinal efficacy; whereas, in the instances before us, it is the human body only which has been aided to resist the operation of certain noxious powers, which would render a perseverance in the antidote prejudicial or impossible.

"The soothing qualities of this admirable medicine can scarcely be estimated too highly; yet we must beware of ascribing effects to them which have no existence; since a confidence in the antivenereal virtues of opium would be a source of greater mischief than its most valuable properties would be able to compensate."

Secondary syphilitic vesicular eruptions. From some peculiarity in the patient's constitution, or from some want of power in carrying out the natural processes of the disease, the syphilitic eruption may be accompanied by an effusion of serum only. The diseases thus produced have received a variety of names, according as they have resembled other diseases of the skin. Thus we have described *syphilitic herpes*, *syphilitic eczema*, the *varicelloid syphilitic eruption*, the *impetigenous syphilitic eczema*.

When the effusion of serum beneath the cuticle is larger, bullæ are formed instead of vesicles, and then the disease is described as syphilitic pemphigus. These all are only accidental modifications, and do not belong to the essential nature of the syphilitic disease. They may pass one into another, and be preceded or followed by other forms of eruption. They do not, consequently, require any separate and distinct mode of treatment.

Secondary syphilitic ulceration of the skin. About the period when a patient's constitution gives evidence of being affected with the syphilitic poison, the original primary chancre will often ulcerate in a way that it had not done before; at this period also, as the consequence of that ulceration, the corresponding lymphatic glands will become affected, and sometimes suppurate, as has already been explained. These ulcerations must be regarded altogether as of a secondary nature; and they are frequently healed with much difficulty. The secondary inflammation of the skin may, in like manner, in any situation terminate in ulceration; but this ulceration is generally not of that specific and peculiar kind which in the beginning of this article was described as ulcerative inflammation. The absorbent glands, which receive the lymphatics from the ulcers now under consideration, become often enlarged, especially at the back part of the neck; but they do not, as a rule, suppurate. Large portions of skin are often destroyed by these secondary ulcerations; and if they occur upon the face, they leave great disfigurement.

No remedy is so efficacious for these secondary ulcerations as the calomel vapour-bath. It generally happens that it is advantageous to bring a patient's system under the influence of mercury; and then the general calomel-bath should be used every night, taking care to have the parts ulcerated as much exposed to the vapour of calomel as possible. But in cases where a general mercurial affection of the system is not desirable, a local fumigation will answer the purpose. Different plans are adopted for the local calomel fumigation; the only essential condition is, that the volatilised calomel should come in contact with the ulcerated surface which it then covers in a state of most minute subdivision.

The ordinary fumigating-lamp, used without water, answers the purpose of local fumigation extremely well. Five or ten grains of calomel may be volatilised, and the ulcerated part should then be held directly over the lamp. The vapour of calomel ascends perpendicularly, and is deposited upon the first surface with which it comes in contact.

There is a form of ulceration of the skin in patients affected with secondary syphilis which does not depend upon the direct influence of the syphilitic poison, but which is extremely liable to be mistaken for those that do. The ulcerations now referred to generally occur where some portion of bone about the skull has become affected, and where, either by direct irritation or by reflex action, the nerves going from the brain or spinal chord are kept in a chronic and persistent state of morbid irritability.

Dr. Brown-Séquard has shown that if a part be deprived altogether of its nervous influence, the blood-vessels will become dilated; the nutrition of the skin will be maintained, but at a higher temperature than natural. If a nerve, on the other hand, be subject to chronic irritation, the part which it supplies will be very prone to fall into a state of chronic and persistent ulceration. For this form of ulceration calomel-fumigation cannot be relied upon, until the cause of the irritation is removed.

Secondary syphilitic disease of mucous membranes. When a portion of mucous membrane becomes exposed for any length of time on the surface of the body, it gradually assumes the characters of skin and becomes covered by cuticle. Secondary syphilitic eruptions here present the same characters as upon the true skin; but in the mucous membrane itself the appearances of these eruptions are necessarily modified. These membranes are little prone to the adhesive form of inflammation; and although they may be affected at the same time, and from the same cause, as the skin, yet the peculiar characteristics of the adhesive inflammation will not in them be generally fully developed. In those situations, however, where the mucous membrane joins the skin, and especially when from exposure and irritation it has become thickened and assumed the nature of skin, the different forms of syphilitic eruption will be well marked. Every form of syphilitic affection of the skin has its counterpart on the mucous membranes; but the appearances will be modified by the comparative thinness of their structure, by the absence of cuticle, and by the little disposition these parts have to take on the adhesive inflammation. There are some of these which require a particular notice.

Mucous tubercles correspond to tubercles upon the skin. They have generally a more extended base, with a flat surface, or the edges raised above the centre. Although dependent in their origin upon the adhesive form of inflammation, yet they soon suppurate, and so far lose their original character. Mucous tubercles are much more easily influenced by local treatment than tubercles on the skin. A solution of bichloride of mercury, one or two grains to the ounce, or some mercurial ointment, or calomel-powder, are very effective applications. These mucous tubercles affect the inside of the cheeks, the arches of the palate, the lips, the parts of generation, and the rectum. In the latter situation they are very likely to be mistaken for warts, from which, however, they ought carefully to be distinguished. They may both be communicated by impure contact: but the mucous tubercle is a secondary syphilitic affection, requiring constitutional treatment; the wart is a local disease, requiring only local applications.

Deep ulcer of the tonsils commences in general without producing pain or other inconvenience. The mucous membrane is of a livid red colour, and passes rapidly into a state of ulceration. The ulceration spreads, extending in every direction alike, and often produces a deep circular ulcer with sharp edges. It has often a yellowish base; but this varies according to the nature of the secretion which adheres to it. This ulcer has been supposed to be particularly influenced by the bichloride of mercury given internally; an eighth of a grain may be given in decoction or tincture of bark three times a day.

The mucous membrane of the pharynx and larynx is liable to be affected in secondary syphilitic disease, the former probably more frequently than the latter; but on account of the importance of the parts concerned, the latter has been described separately under the name of *syphilitic laryngitis.* This disease is sometimes accompanied by a fixed pain on a level with the thyroid cartilage, and there is occasionally evident swelling externally; the voice, breathing, and deglutition may all be more or less interfered with. There is generally a hacking cough from attempts to expectorate, and some puriform matter streaked with blood is occasionally expelled.

If the disease continues, it is sometimes accompanied by emaciation, night-sweats, and dangerous exhaustion of the patient's system. Portions of the hyoid bone, or of the thyroid or cricoid cartilages, may be destroyed by this disease, and pieces of those cartilages have been known, when disengaged, to pass down one of the bronchial tubes into the lungs. For further information on this head see DISEASES OF THE LARYNX.

Syphilitic iritis has always occupied an important position in the description of secondary symptoms, both on account of the importance of the parts concerned, and also because in the eye alone we can see the alterations that take place in the interior of an organ, and from what we there see we are enabled to judge of similar changes that occur elsewhere. It has been thought better, however, to reserve the consideration of this affection for the article on DISEASES OF THE EYE, to which the reader is referred, and to the excellent description of iritis by Mr. Tyrrell.*

Tertiary syphilis. In tertiary syphilis there is the same tendency to the effusion of a plastic material from the blood that we have traced throughout. Indolent nodules are formed in the skin, which very slowly desquamate, or ulcerate, or become phagedænic. In the cellular tissue circular deposits are formed, which after a considerable time become softened down. The skin over them breaks, and a ragged ulcer is left, with overhanging edges, the cellular tissue having been destroyed to a greater extent than the skin.

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* *On Diseases of the Eye*, Lond. 1840, vol. i. pp. 339 et sqq.

In the substance of the heart, in the liver and other internal organs, even in the structure of nerves, the same deposit may sometimes be found. These formations occur in irregular masses, often of a more or less circular form, and may remain, probably without undergoing any material change, for a very considerable period. There is little doubt but that, under appropriate treatment, they may be entirely reabsorbed. These tubercles must be distinguished from the results of ordinary secondary inflammation, such as occur after surgical injuries and operations. But it must nevertheless be observed, that patients labouring under syphilis, even in its tertiary forms, are more liable to secondary deposits after surgical operations than others.

Tertiary syphilis, in one form or another, may probably affect every structure of the body. But the diseases thus produced so much resemble those that arise from other causes, that from the morbid changes alone, independently of the history of the case, it would often be impossible to distinguish them. The limits of this article necessarily preclude a description of all the tertiary syphilitic affections which may be produced in individual organs; and, indeed, the description of those diseases, and the particular points in which they differ from affections arising from other causes, can with more propriety be noticed under the head of the diseases of the several organs in which they occur. A general description only of some of the most important tertiary syphilitic affections will therefore be here given.

Diseases of skin and mucous membranes. These consist mainly of ulcerations of a peculiarly unhealthy and persistent character, attacking various parts of the body, but chiefly portions of the face, nails, ears, and mucous membranes of the various openings of the body. In many instances no secondary affection of the part involved has preceded these ulcerations, whilst in others, and especially those which are found on the face, the disease seems to consist of an extension of ulceration from a previously existing secondary sore. The parts of the face usually attacked are the nose and lips; in the former a tubercular nodule is most commonly noticed on the ala of the nose. This is a hardened copper-coloured mass, varying in size from the eighth of an inch and upwards, and often remains for many months without undergoing any material change, and then perhaps in some temporary depression of health it will break out suddenly into an open sore, and extend itself by rapid ulceration; or the ulceration may be more slow and gradual, eating through the cartilages of the nose, and reaching to the inner cavities; in both cases with more or less destruction of the sense of smell, and a decided change of voice. Occasionally the ulceration begins from within, and extends outwards, producing similar destruction of parts. If the ulcerative action should not be arrested, it will progress more deeply, attacking the bones of the nose and all structures in its neighbourhood, and completely destroying the sense of smell.

The disease of the lips commonly begins with a few cracks in either lip, which, like the preceding, may remain for weeks or months, and then ulcerate extensively.

The parts about the nails are liable to similar ulceration. That most generally observed is an ulceration of the root of the nail, of an obstinate and unhealthy nature, of a dark, almost black colour, and surrounded by a deep copper-red margin. It is a form of onychia extremely difficult to eradicate, as the ulceration is very apt to return. It occurs either on the fingers or toes, though most commonly on the former. Similar ulcerations occur between the toes, and are characterised by a more offensive discharge than the preceding. When the nutrition of the skin is thus affected, the bulbs of the hairs are involved. The hair, being imperfectly nourished, becomes cracked, dry, and split at its extremities. It often breaks off short at the roots, and comes away in considerable quantities in the comb. When the bulbs are much affected, the hair is not reproduced, and partial or even entire baldness is the result. This has been called *alopecia.* It may affect the beard, the eyebrows, and eyelashes. A case is recorded by Vidal where it was complete, causing total loss of hair over the whole body.

The mucous membranes most liable to attacks of syphilitic ulceration are those covering the tongue, gums, rectum, vagina, and os uteri. There is nothing remarkable about the two former, except that, as the parts are more freely supplied with blood, the action is apt to be more energetic and rapid than in other cases. Accordingly ulcerations of the tongue are often seen of large size, even when of recent date; and when the gums are diseased, the teeth frequently become involved and lost.

Syphilitic inflammation, or rather ulceration of the intestines, is now recognised by many physicians as an occasional cause of long-continued dysentery. The part commonly involved is the colon, and occasionally the small intestine near the ileo-cæcal valve. It can but be determined by the history of the case under notice; and in many instances the diagnosis of syphilitic dysentery is rather an inference from the facts, that syphilis has existed in the patient, and that no other sufficient cause can be assigned for the dysentery.

Diseases of periosteum, bones, and joints. Perhaps the most important of all these tertiary affections are those which attack the bones and their coverings.

They may be included under the heads of periostitis, acute and chronic; nodes and exostoses; inflammation of bone; caries and necrosis.

Acute periostitis is a rather rare result of syphilis; but when it exists, it is apt to be extensive and destructive. Chronic periostitis is very common. It attacks almost exclusively those parts of the bones which lie immediately beneath the skin; the forehead, sternum, and tibia particularly. It is attended with great pain at night, and aching at every change of temperature or weather. When occurring on the tibiæ, it frequently leads to the formation of nodes and exostoses, and these, too, are often extremely sensitive.

The interior as well as the surface of bones may be affected. The cancellous structure becomes thickened, condensed, and often much harder than natural. Fixed and long-continued pain in the bone, without much tenderness of its surface, characterises this condition. The pain appears to arise from the pressure produced by the increased formation of bone, and is relieved, often permanently, by making an opening through the crust of the bone with a trephine. No fluid is found in the interior of the bone on these occasions.

Caries and necrosis of bone occur as tertiary forms of syphilis in the same parts as from other causes, the former in the cancellous structure, and the latter in the shafts of long bones or the dense parts of others. Necrosis is generally the result of acute periostitis. Caries is almost always produced by an extension of ulcerative action from soft parts to the bones. Thus, the bones of the ear are often affected by ulceration of the cartilage or lining membrane of the meatus; the bones of the palate, from ulceration of the mucous membrane lining it; the bones forming joints, from ulceration of the soft structures of joints. It is very rare for caries to begin as a primary disease in tertiary syphilis. During this ulceration of bone, serious destruction may take place. Joints may be disintegrated, the organs of hearing lost, and the bones of the nose or palate destroyed. The bones of the skull are usually affected in their outer and middle tables only. The diploe becomes filled with bony matter, and then ulcerates or dies. Sometimes, although rarely, the inner table is affected to a greater extent than the outer or middle. Effusion may then take place between the bone and dura mater, and the disease may be extended by continuity of action to the brain. The brain may then become affected with red softening, and a part of it ultimately softened down to the consistence of cream. In these cases it is the surface of the brain which is primarily affected; but in those cases where the brain has been supposed to be affected independently of the bones, some of the central portions, such as the corpora striata, are the parts that have been found softened.

Diseases of glands. Of these the only gland requiring especial notice is the testicle. This is liable to three distinct kinds of tertiary diseases, viz. enlargement, atrophy, and tubercular deposit. All these have one thing in common,—a diminution of the effective power of the gland. In the case of enlargement, nothing but an apparent increase in the normal structure of the gland can be noticed. The shape of the testicle is retained, and there are no irregularities of surface to be observed. The increase appears to depend upon a hypertrophy of the fibrous, rather than the secreting, structures of the testicle. In atrophy the gland gradually diminishes, until it becomes scarcely half its proper size, and the secreting part is obliterated to a corresponding extent. Neither of these conditions is accompanied with any pain. In cases where the testicle is the seat of tubercular nodules, there is frequently much pain, both in the back and along the course of the spermatic cord. These nodules are usually small, two or three in number, rounded, hard masses, projecting from the surface of the testicle, and apparently proceeding from its substance. In structure they consist chiefly of yellow fibrous tissue, containing within its meshes more or less hardened cheesy matter, with a few oil-globules.

The absorbent glands are very frequently enlarged in tertiary syphilis. The condition of those situated in the upper and back part of the neck has, by many eminent writers, been regarded as diagnostic of a patient's system being affected with syphilis, or otherwise. But the absorbent glands are only affected in secondary and tertiary syphilis, in consequence of disease in the parts from whence they have their origin. It very frequently indeed happens, both in primary and secondary syphilis, that there is a sore upon some part of the head, and then the posterior cervical glands will be enlarged; but if the sore be confined to one side only (as, for instance, a chronic ulceration on one cheek), then the cervical glands will be enlarged only on that side.

Treatment of tertiary syphilis. The same general remedies are used for the so-called tertiary as for the secondary forms of syphilis. Patients labouring under tertiary syphilis, however, often have undergone more than one course of mercury, the effects of which have been ill-regulated or the mercury imperfectly administered. In the great majority of cases, any further prolonged exhibition of mercury internally is out of the question. Iodide of potassium, sarsaparilla, bark, the mineral acids, and opium, are therefore the remedies most generally used. The iodide of potassium is an excellent remedy in many forms of tertiary syphilitic ulceration, in cases of enlarged glands, and in syphilitic affections of the bones. From three to five grains of this medicine three times a day will seldom fail to relieve the pain of a syphilitic node within a few days.

The benefits of sarsaparilla are most marked in those cases in which the patient's constitution has been debilitated by the abuse of mercury, or where the bones have become affected with caries. In order, however, to obtain the remedial effects of this medicine, it should be given in sufficient quantity; a pint of the decoction should be given daily, or half an ounce of the fluid extract three times a day, and continued for some weeks. The iodide of potassium may very conveniently be combined with any of the preparations of sarsaparilla. Bark, iron, and the mineral acids are all of use in restoring the strength of the patient, impaired either by the disease or by the injudicious use of remedies; and opium, by relieving pain and giving rest, will often prove most useful. But none of the medicines now mentioned will cure syphilis. Every form of this disease may ultimately be cured by the unassisted powers of nature; and the remedies above mentioned may render much assistance, and some of them, especially the iodide of potassium, has a great influence in removing particular symptoms; but they do not cure the disease. The only medicine which can be considered as doing this is mercury; but in the tertiary forms of disease this medicine can scarcely be administered internally, and inunction is apt to be followed by troublesome pustules and ulcerations. Where other means fail, the slow imbibition of calomel through the skin affords an excellent means of introducing the medicine into a patient's constitution. If this remedy is really indicated, there is scarcely any condition in which it may not be used. In consequence of not interfering with the internal organs, it does not in any way increase the weakness under which the patient may be suffering, and may be given as a patient lies in bed. A large class of cases, in which a few years ago mercury was thought altogether inadmissible, are now habitually and effectually treated in this way. The action required is less than in cases of secondary syphilis, but it should be maintained for an equal length of time. Ten grains of calomel, used with the fumigating-lamp as described (p. 421), are often sufficient; and if there are any open sores, still less may sometimes be used. Any of the usual tonics may of course be administered internally, at the same time that the patient is using mercurial fumigation. If the patient suffers much from perspiration, the calomel may be volatilised at a low temperature without any water. In this way any increase of debility in consequence of the sweating will be avoided. In cases where a patient's constitution has not been impaired, other forms of mercury may be used.

Some of these have been thought to be peculiarly adapted to one kind of affection, and some to another. Thus, for iritis calomel has generally been given internally, combined with opium. For the deep ulcer of the tonsils the bichloride of mercury has very often been prescribed; and for eruptions on the skin the proto-iodide of mercury has been most extensively employed. But, generally speaking, whatever may be done with these remedies, may also be effected by the imbibition of mercury through the skin; and the adoption of this mode of treatment, when properly carried out, is attended with a great saving of the powers of the patient's constitution.

CHAPTER IV.

Local Syphilis.

Primary Suppurating Sores.

It is to this kind of chancre that M. Ricord's description alluded to in p. 377 applies; but that description does not apply to other forms of syphilitic infection. Much confusion has arisen from writers upon syphilis taking for granted that all syphilitic disease must necessarily originate in the same way. So great was this tendency to generalise that even M. Ricord* himself, in describing in one of his earlier writings the natural course of this disease, says (after tracing the formation of the primary syphilitic pustule), "à partir du cinquième jour les tissus sousjacents s'infiltrent et durcissent par l'épanchement d'une lymphe plastique, qui donne au toucher la résistance, la sensation élastique, de certains cartilages."

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* *Traité pratique des Maladies Vénériennes*, p. 89.

Two morbid actions quite distinct from each other are here involved in the same description, and those who have blindly followed M. Ricord's statement have added much to the confusion that already prevailed. The specific induration is the result of the adhesive inflammation, and is not produced by the suppurative. These two actions are so distinct that they have been regarded as the effects of different poisons; and numerous most elaborate and ingenious efforts have been made to show that the product of the adhesive inflammation gives rise exclusively to the specific induration; the product of the suppurative inflammation to the specific pustule.

However this question may ultimately be decided, there can be no doubt that the actions are essentially of a different nature, and followed by different results. The suppurative inflammation commences immediately on the application of the poison; it has no period of incubation; and it naturally terminates without leaving any specific induration.

As seen in practice, the suppurating sore usually commences as an abrasion, and consequently no vesicle or subsequent pustule is observed, because the cuticle, which otherwise would have confined the secretion, has already been destroyed. It rarely happens, in fact, that natural inoculation of this kind of sore takes place, unless the cuticle have previously been abraded. Unlike the specific adhesive inflammation, it often attacks several parts at once, and may be repeated upon the same individual a great number of times (see p. 384). It may assume any shape, according to accidental circumstances; but its form is generally round. When fully developed, it often presents the same appearance as if a piece of skin had been removed by a circular punch. The borders are clearly defined, and often slightly undermined. The surface of the sore is tolerably smooth, and covered by ill-formed granulations. It is generally found in those situations where diseased secretions are most likely to lodge, and where the cuticle, from its delicacy, is most likely to be abraded. The ulcer generally extends itself in every direction alike, so that it maintains more or less its circular character. Its base is somewhat thickened; but this thickening does not terminate in the abrupt way that the thickening around an infecting sore does, and it is generally much less in extent.

The secretion from this class of sores is purulent after the first four or five days from the period of infection. When examined under the microscope, it is seen to consist almost entirely of pus-globules floating in an albuminous fluid. On the addition of acetic acid, each cell exhibits the compound nuclei characteristic of pus. The quantity of secretion is comparatively large, and sufficiently fluid not to adhere to the surface of the wound. The skin around the sore is slightly engorged, giving it a pale-red colour.

After continuing for three or four weeks, this ulcer generally heals, and it does so without leaving any of the peculiar induration, so characteristic of the infecting sore.

The absorbent vessels and glands are not affected in this disease, which is strictly limited to the part that has received the infection.

Phlegmonoid suppurating sores. When the suppurating syphilitic sore extends below the skin or the mucous membrane, it necessarily involves the cellular tissue. From its comparatively loose structure, this part requires a much greater amount of effusion, in order to limit an inflammatory action, than either the skin or the mucous membrane, and consequently the suppurating chancre is here surrounded often by a considerable amount of induration. This induration, however, generally fades gradually in the surrounding parts, and does not terminate abruptly. It will nevertheless sometimes happen, where a membrane or a different structure is found near the confines of the disease, that the induration will there terminate quite abruptly; and then from the feeling alone there is no means of distinguishing this induration from that of an infecting chancre. Here it is that the character of the secretion is of so much value in assisting to form a diagnosis. If the secretion consist of pus which, upon the addition of acetic acid, presents the characteristic compound nuclei, the disease is a local one; it is a variety of the suppurating sore. If the secretion is of that nature which has been described under the head of the infecting sore, the disease is a constitutional one, and will infect the patient's system.

The great importance of this diagnosis is too obvious to be further insisted upon. But it must be understood that, in order to be of any value, the natural secretion of the sore only must be examined. If a sore has been subjected to any artificial irritation, the character of the secretion becomes temporarily altered, and can then be of no use in determining the nature of the affection.

The phlegmonoid variety of the suppurating sore generally lasts much longer than when the disease is confined to the skin or mucous membrane. It is surrounded by a raised margin of skin of a deep-red or violet colour.

Treatment of suppurating syphilitic sores. The syphilitic poison requires a living nidus for its development, and a certain period must elapse before its specific action can take place. If within the first five days of the application of the poison, the part to which it is applied be destroyed by caustic, the death of that part will determine the cessation of the morbid action. This cauterisation, to be effective, must, however, extend to all the tissues which have imbibed the poison. It can, therefore, only be practised with success in the case of those chancres which appear within a very few days of the application of the poison. If a period of incubation have taken place, the tissues will have so imbibed the poison, that it will be in vain to attempt to destroy all the parts that have been infected.

Suppurating sores generally make their appearance immediately upon the application of the poison; and to these, therefore, the method of treatment by cauterisation is admirably adapted. The caustic should be applied to every part of the sore, and allowed to remain until it has destroyed a certain depth of substance. For the purpose of securing this result, strong caustics should be used; and as these may sometimes extend further than is intended, it is always advisable, before applying the caustic, to have an antidote at hand, so as to limit its action when desirable. When the caustic has produced its requisite action, the antidote may be applied; this will have the effect of preventing the further extension of the caustic, and also relieve the pain to which it gives rise. Thus, if a strong acid be used, a solution of carbonate of potash, or chalk, will form a good antidote. If an alkaline caustic be employed, some vinegar may very conveniently be used to limit its action. When nitrate of silver is applied, the common olive-oil is the best subsequent application.

The caustics most used for the purpose of destroying the suppurating syphilitic sores are the mineral acids, and a combination of potash and lime. The nitrate of silver will seldom extend sufficiently deep to eradicate the disease.

The nitric acid has often been employed, and acts extremely well; but it gives very considerable pain when applied to the surface of the body.

Another preparation which has been very much used is a combination of sulphuric acid and powdered vegetable charcoal. According to M. Ricord, when this preparation in the form of a paste is applied to a chancre, it dries quickly, and forms a kind of black crust, which remains adherent to the tissues, combines with them, and is not detached for several days, when the wound will be found to have lost its specific qualities and to be in a healing condition. The application of this caustic causes very severe pain, which lasts for a considerable period. The pain, however, is said to be less than that produced by the nitric acid; but then it does not admit of being relieved in the same way by the application of an antidote.

Perhaps the most convenient form of caustic is the *potassa cum calce*, as prepared in the shape of little rods for the purpose. The lime combines with the moisture of the parts, and prevents this from extending itself over the neighbouring surface. The extent to which this caustic acts may therefore be regulated in the most accurate manner; and after it has done its duty, the application of some dilute acid will relieve the pain which it has caused.

The suppurating syphilitic sore, if not in its origin destroyed by caustic, will generally run its course of five or six weeks' duration, and heal of its own accord, without leaving any injurious effects either in the lymphatic or in the patient's general system.

Ulcerative Syphilitic Inflammation.

This term is used to express that kind of increased action in which the absorbent vessels play a prominent part, and, either from the surface of an ulcer or by interstitial absorption, take up, together with the natural particles which they are intended to remove, a portion of the syphilitic virus. This action is usually accompanied by a breach of surface, or ulcer: but, as shown by Mr. Lane, one of the consulting surgeons to the Lock Hospital, this is not invariably the case; an imbibition of the poison may take place without ulceration by interstitial absorption, and may be conveyed along the lymphatics without breach of surface: still in the very great majority of cases an ulcer does form, and from its surface the poison is doubtless taken up. As in the infecting variety of syphilitic sores the specific induration may be quite superficial and of very limited extent, so in the variety under consideration the ulceration may be extremely small. Its character, however, is peculiar. It is a ragged, worm-eaten ulceration; secreting an ill-formed pus, and presenting an irritable surface. Soon after the appearance of this sore, one of the glands in the groin will become enlarged and painful. This may be preceded by a shivering-fit, more or less well marked. The patient will be unable to walk without inconvenience. When examined, a circumscribed, tense, rounded induration will be felt under the skin, which as yet retains its natural appearance; any pressure upon this part gives great pain. There is some general disturbance of the patient's system. The swelling increases; in a day or two the skin becomes red immediately over the inflamed gland. The redness is the deepest in the centre, and gradually fades to the colour of the surrounding skin. Suppuration soon takes place, and as soon as the pus is discharged, the patient is relieved.

The pus which first points is usually derived from the cellular tissues around the infected glands. This pus possesses no specific qualities, it cannot be inoculated so as to produce a syphilitic ulcer in another part. But there is a fluid more or less puriform in character, which is derived from the affected glands themselves; this may with tolerable certainty be inoculated, and it will give rise to a characteristic pustule, identical in appearance to that which would be produced by inoculating the secretion from a common suppurating syphilitic ulcer. These two fluids, so different in their qualities, can only be distinguished at the time when suppuration is first established. As soon as the matter within the gland becomes discharged, it mixes with the pus from the surrounding parts, and often renders the whole capable of being inoculated, and consequently the whole surface exposed becomes a syphilitic ulcer.

The observation of a very large number of cases, which for several years were tabulated at the Lock Hospital, enables the author to say, that this action which has now been described under the name of ulcerative inflammation is not followed by constitutional syphilis. It is not of course intended to imply that this morbid action is a *preventive* against constitutional syphilis, nor must it for a moment be supposed that every suppurating bubo is of the nature here indicated. This disease may with a little attention be distinguished from every other; and when recognised, will enable the surgeon to assure his patient that if he has no other source of infection, he will not be liable to secondary symptoms.

The course of the poison in this disease may be traced in the clearest manner. In any part of its transit from the ulcer to the absorbent gland, it may inoculate the vessel in which it is contained, and there produce a fresh syphilitic sore, the secretion of which may be again inoculated. It usually happens, however, that the inguinal gland in which the absorbent vessels terminate is the part affected. Here alone, in the great majority of cases, does the poison exert its influence upon the absorbent system; but that the poison actually passes as such through the absorbents, we have abundant proof in the occasional formation of specific abscesses in the course of these vessels. In these cases a small abscess forms between the bubo in the groin and the inflamed and irregularly ulcerated surface at the seat of the primary disease. Such an abscess presents tumid and irritable edges, and furnishes an inoculable pus; and both in the undermining of the skin and all other respects, with the exception of its size, offers a counterpart to the specific inflammatory bubo.

Thus the actual existence of the virus in any part of its course may be demonstrated. Arrived at the absorbent gland, apparently on its way to the thoracic duct, and thence to the general circulation, what becomes of this poison? A wonderful change is here brought about. The specific virulent poison, which before was liable to contaminate every part with which it came in contact, cannot now be traced beyond this point. The absorbent vessels between the inflamed gland and the thoracic duct do not ulcerate or suppurate; the glands into which they empty themselves do not become enlarged and inflamed. The influence of the poison is here, then, gone. Beyond the glands first in order, the fluids which the absorbent vessels contain are bland and harmless, incapable of being inoculated. In a certain number of cases, no doubt, the poison is in a great measure discharged in the suppuration to which its presence gives rise. But when we consider the exceedingly minute quantity of an animal poison that is capable of producing its specific action on a part, this explanation is not sufficient. Some of the fluid or particles which enter the gland must in some form or other pass through it whether it suppurate or not. Even although the inflammation produced in the gland entirely obstructed its channels, still before such obstruction could take place some fluid would necessarily have time to pass; and this, if its quality remained unchanged, would be abundantly sufficient to inoculate any part with which it came in contact.

A somewhat analogous circumstance is observed in cases of cancer. The first set of glands which the absorbent vessels coming from the seat of the disease reach are alone inoculated. The glands second in order, nearer the centre of the circulation, may be enlarged, but they are seldom the seat of malignant disease. A case recently came under the author's notice, of a patient with obstinate chronic enlargement of the right labium, presenting all the characters of epithelial cancer. Shortly before the woman's death the inguinal glands suppurated; but on examining the body afterwards, no affection of the glands within the abdomen could be discovered. The facts presented by such cases must be carefully distinguished from any theoretical explanation of them. Yet it is fair to attempt to give a rational explanation of the conditions observed: such an explanation leads to further inquiries into similar actions elsewhere, which may throw light upon the subject immediately under consideration.

Independently of the essential nature of the affection, more glands will be found to be affected in malignant disease than in syphilis. This may be partly accounted for by the relative extent of parts affected in the two cases. In the first, the absorbent vessels, derived from different parts of the disease, may communicate the affection to several absorbent glands; in the second, the extent of parts involved is usually very limited, and the absorbent vessels leading from it are also limited in number.

If we reflect on the different ways in which foreign substances can be taken into the living body, we shall find that every such way is furnished with certain sentinels or guards which oppose the entrance of materials which, if admitted, would prove injurious. Thus, in addition to the sense of touch, the mouth is guarded by the sense of smell and that of taste,—three out of the five senses concentrated around the opening by which the food enters into the system, and one at least of the other two always ready to assist in affording information of its nature. If we trace the food onward, we find it has to pass the double row of teeth, which are acutely sensible of the presence of any hard particles which may have been accidentally mixed with it. Should any fresh flavour be produced in the progress of mastication, there are means provided for appreciating it as the food passes through the posterior fauces. The stomach we find ready in its turn to reject that which is injurious; and throughout the alimentary canal there is an apparatus composed of a multitude of different parts, all combining to hurry on and eliminate from the system any materials which, if left, would be detrimental to it.

Finally, there is provided a wonderful system of minute capillary tubes, taking up and pouring freely into the blood that which is required for the nourishment of the system, but refusing to admit any thing else. These lacteals are very similar in structure, disposition, and function to absorbent vessels elsewhere. It is true that the processes involved in the assimilation of the different individual organs of the body cannot be traced equally well as in the analogous actions which convert the food originally into part of the living being: but there is abundant evidence that the same care is taken with regard to each part as with respect to the whole; and there is much reason to believe that other channels, through which foreign matters may enter the system, are guarded with the same care as that by which the common food is received.

Such facts lead to the conclusion that some means must exist for preventing the indiscriminate introduction into the circulation of any materials which might find their way into the absorbents during the active ulceration of a part; and observation demonstrates that such a provision actually exists. The particles taken up by absorption ultimately again form part of the general circulating fluid from which they were at first derived. They have as much to be assimilated as animal matter taken fresh into the stomach. The bone, the tendon, the muscle, the nerve, which are thus removed can no longer be recognised as such after they have been acted upon by the absorbents. All the different tissues that undergo this process form a single fluid, which ultimately becomes a part of the general circulating mass, and can then in no way be distinguished from similar products derived from the process of ordinary digestion. The action which converts foreign animal matter into blood, and that which converts parts of the living body into blood, by the agency of the absorbents, are then analogous; and they agree in possessing the very remarkable property of converting some substances which, when introduced in any other way, act as poison upon the system, into harmless agents. It has been shown by the Abbé Fontana that the poison of the viper, when introduced into the stomach, undergoes some change which prevents its poisonous effects upon the system. It has also been shown by two French physiologists that the same thing happens with regard to the woorara poison; and we have it upon no less an authority than that of Sir B. Brodie, that opium may be digested in the stomach of some animals, and that in that process its poisonous qualities are destroyed. In like manner we find that cancerous matter cannot pass from a part to the general system through the lymphatic glands; but there is evidence to prove that it may, under certain circumstances, be so propagated through the blood-vessels. It is true that the veins in the immediate neighbourhood of a cancer are very generally blocked up with coagula, affording another instance of the preservative power above mentioned; but when this is not the case, the cancer-cells may be conveyed in the course of the circulation and infect distant parts. There is an experiment by Langenbeck related in the *Encyclopédie Anatomique*, in which some fresh cancerous matter was injected into the veins of a dog, and cancerous tubercles were consequently developed in the animal's lungs.

In like manner, it might be possible, under certain peculiar circumstances, to infect the general system with cancer through the absorbent vessels; but the fact already mentioned, that the glands first in order only are affected in consequence of local cancerous disease, forbids the idea that this is the way in which the disease is usually conveyed to other parts.

These observations will prepare for the consideration of the change that is produced in the syphilitic poison during the passage of the matters in which it is contained through the lymphatic glands. These materials are themselves undergoing a change which will fit them for becoming a part of the circulating fluid; and it would seem that the poison itself undergoes a change similar to that produced in the poison of the viper or in the woorara poison in the stomach.

The action of the syphilitic poison must not, however, be confounded with that of other poisons, which produce their effects immediately upon their application. A definite and peculiar action has to be gone through before the syphilitic virus can, under ordinary circumstances, infect a part. This action may vary in different instances, but a certain interval must elapse before the poison can be absorbed so as to produce its specific effects. During this period it is that the ulcerative inflammation takes place in the class of cases which we are now considering.

In this process of ulceration the freshly contaminated parts are constantly being removed; the tissues infected one day are removed the next. Now all experiments in inoculation have tended to prove that the syphilitic poison, when removed to a fresh part, has to begin afresh the morbid action peculiar to it before it can infect that part; and this it does as far as the first lymphatic gland with which it comes in contact.

Here a power is manifested which arrests its further progress, a power which bears some analogy to that which is evinced by the stomach in the conversion or rejection of poisonous substances. The difference in the nature of the fluid in the lymphatic vessels, before and after it has passed the inguinal glands, is analogous to the difference in the qualities of the woorara poison before and after it has undergone digestion in the stomach and the lacteals. In both cases do the fluid contents of the lymphatic vessels undergo a change in the glands, fitting them to become a part of the circulating fluid; in both cases they are sometimes converted and assimilated, and sometimes rejected—by vomiting in the case of the stomach, and by suppuration in the case of the lymphatics.

In taking an inflamed or suppurating bubo as a test of the action which has been going on in the primary seat of the disease, some little care may be requisite to distinguish the effects of the specific disease from any other accidental causes of irritation. In strumous subjects a very slight increased action may be the means of producing an enlargement of the inguinal glands, which may readily terminate in a kind of suppuration; and in these patients other venereal affections (besides that just described) may be followed by suppuration of the absorbent glands in the groin. The disease may be suspected to be scrofulous if several glands are enlarged, and especially if several are enlarged upon both sides, or if they attain a considerable size without producing much pain, or if a considerable time elapse before they break.

Again, the repeated application of caustic will sometimes give rise to an irritation, which will produce suppuration of the inguinal glands. By this means the character of the affection may apparently be entirely changed; a sore, which in its origin was indurated, may subsequently present the characters of acute ulceration. Such an action, produced in the later stages of the affection, would not prevent the effects of the primary disease, for they may have begun to develop themselves even before the caustic was applied.

Another source of error in the interpretation of symptoms in these cases is the existence of previous disease. It will often happen that during the suppuration of a bubo, from whatever cause arising, the general health will become impaired; and, under these circumstances, it is very probable that any syphilitic symptoms which had previously existed may reappear, and the converse of this not unfrequently happens. Some form of secondary disease will appear upon the organs of generation, and then the lymphatic glands may suppurate as a part of the secondary symptoms. A careful investigation of the history of the case will enable the surgeon to trace the occurrence of such symptoms to their real source.

Treatment of syphilitic ulcerative inflammation. The ulcer which accompanies this disease is often irritable and painful. Opium locally applied, and administered internally, is then a useful remedy. In most respects this ulcer may be treated in the same way as the primary suppurating sores. Various plans are mentioned in works on surgery for preventing buboes from suppurating. None of these are of any avail in the disease under consideration; sooner or later the gland will suppurate, and the best practice is to facilitate this by every means in our power. To retard it would only be to retard the patient's ultimate recovery.

After an abscess has burst in the groin, at the bottom of the cavity the remains of a diseased inguinal gland may sometimes be seen, which does not granulate like the surrounding parts. This gland should be destroyed by caustic or by the application of the nitric oxide of mercury. If care be taken to limit the application to the gland only, the operation may be performed without giving the patient pain.

Destructive Syphilitic Inflammation.

It is a very remarkable fact that some of the most vascular parts of the body, and those the best supplied with nerves, are, under certain circumstances, the most prone to mortification. The parts of generation, amply supplied with nerves and blood-vessels, will, under the influence of the syphilitic poison, occasionally become intensely inflamed, and that inflammation will speedily terminate in gangrene. If the gangrene so produced occurs within a short time after the application of the syphilitic poison, the death of the part involves the destruction of the poison. They together cease to exist; and, when the slough separates, an ordinary sore alone remains, requiring no specific treatment.

Mortification of some part of the organs of generation sometimes appears to depend upon a diseased state of the blood, independent of any local cause. The blood will stagnate in the capillaries of the skin here as elsewhere; and the tendency to mortification will first show itself in the most vascular parts. The skin will be affected before the areolar tissue, and the areolar tissue before the fibrous and membranous structures.

The mortification will sometimes be of the dry kind, but generally it will be of the moist variety. In the first there will be little pain or swelling, but in the second there will be much effusion, with great pain and a considerable amount of constitutional disturbance. Both these varieties may occur where there is no evidence of the disease having arisen from the application of the syphilitic poison; on the other hand, patients in apparent health will sometimes, within three or four days after exposure, find some part of the organs red, swollen, and extremely painful. In the centre of the inflamed part a dusky spot will indicate that the blood has already begun to stagnate in the vessels. The nutrition of the parts is no longer maintained; irregular excavations are made by small portions of the tissues being thrown off in the sanious discharge. The whole part affected becomes of a darker hue, and ultimately presents the ordinary appearance of gangrene. After a time a line of demarcation is established, the slough is thrown off, and the wound generally cicatrises without difficulty. This process, effected by nature, is very similar to that which is artificially produced by the application of caustic to a syphilitic sore. In both cases, if the mortification has reached all the parts which have imbibed the poison, the destruction of the poison will take place in that of the tissues which contained it. In this first variety of mortification (p. 399), as it occurs naturally, there is very seldom indeed any subsequent affection of the patient's system, even supposing he has been in a position for contracting an infecting sore; and the reason of this doubtless is, that the action which terminates in mortification commences at the same time as, or very soon after, the application of the poison. In cases where the mortification has been artificially produced, on the contrary, a period of incubation may have existed of some days or weeks before the disease has shown itself, and consequently before the caustic is applied; and during this time the tissues may, in all probability, have imbibed the poison to a greater extent than the caustic can reach.

The morbid action, which we are now considering, appears to be communicable by contact, although this cannot be so closely traced as in the other forms of syphilitic inoculation. In patients, for instance, in whom the general health has not been impaired, parts which have no direct connexion, either by blood-vessels or nerves, will appear to infect each other. Thus the glans and the prepuce, the opposed surfaces of the labia or of the nates, will become affected in a similar manner and exactly to the same extent; and when the ulcerative form of inflammation has preceded the gangrenous, the destructive action is tolerably sure to be communicated from the primary sore to the corresponding inguinal gland, and from it to the surrounding areolar tissue and skin.

The second form of destructive inflammation (see p. 399) is by far more common, and ordinarily of much longer duration. In it the infected tissue perishes slowly, bit by bit, by a kind of molecular necrosis; and, in consequence of this tardy action, the whole of the infected portions never perish at the same time. A part is always left as a focus of contagion, and this involves fresh portions, which, in their turn, are thrown off, but not before they have communicated the disease to parts beyond. This action constitutes the *phagedænic* syphilitic sore. It may appear as an original disease, or it may supervene upon any of the forms already described. It is inoculable, and generally arises from the direct result of the application of the syphilitic poison; but secondary forms of syphilitic disease may assume precisely the same characters. These, however, cannot readily be inoculated upon the patient, whereas the primary phagedænic ulcer can.*

The phagedænic ulcer spreads irregularly in different directions, is accompanied often by much pain, and yields a profuse discharge. This consists of an ill-formed sanious pus, mixed up with the débris of organic tissues. It does not affect the inguinal glands, provided these have not become implicated before the phagedænic action has fairly set in; if they have, the bubo will probably open and present the same phagedænic appearance as the original sore.

There is one form of the destructive syphilitic inflammation which presents very peculiar characters. Instead of spreading from one point in a more or less circular form, the disease may slowly extend in the form of portions of circles, from several points at once; or, while the central portion first attacked heals, the affection will spread in a circular form, continually attacking fresh parts. The skin which is healed will then present a shining glazed appearance, surrounded by a dark-coloured circle of irregular so-called ulceration. This affection has been named the *serpiginous chancre.* Like every other form of chancre, it may be accurately simulated by a form of secondary disease, the capability of ready inoculation upon the patient who has it alone excepted. This affection spreads by a true necrosis; as one part heals, another becomes in succession red, livid, and disintegrated, the particles being thrown off in a thin sanious discharge. The loss of substance is occasioned entirely in this way, and not at all by the action of the absorbents. This form of destructive inflammation will sometimes continue for months, or even years; occasionally nearly healing, and then again, without any apparent cause, spreading in the same peculiar manner. It affects the folds of the groin, the inside of the thighs, and nates, perhaps more frequently than any other parts.

There is one kind of destructive inflammation which must be distinguished from the rest, to which, however, it sometimes, to the eye, bears a very strong resemblance. This is the destructive inflammation that occurs on the surface of an indurated chancre. It will occasionally happen that the effusion at the base of an infecting sore is sufficient to interfere with the due circulation of the part; a superficial layer of tissue may consequently perish, and the indurated chancre will then present the same appearance for a short time as a soft phagedænic sore. This must be regarded as an accidental complication only, and not as a variety of the true phagedænic ulceration.

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* The experiment of inoculating this form of disease should be carefully avoided; for a surgeon can never tell when the artificial inoculation which he produces will heal, and he will have the credit of having prolonged the disease if the original sore should heal before the inoculation.

Treatment of destructive syphilitic inflammation. In the treatment of the acute form of destructive inflammation, it must be remembered, that the action which is taking place may save the patient's system from syphilitic infection. It would not, therefore, be advisable to prevent that action entirely, even if we had the power of doing so. The object of treatment is to restrain it within due limits. For this purpose, fomentations and poultices are generally sufficient as local applications. Leeches in considerable numbers have been recommended, but the ultimate benefit derived from them is doubtful; and the leech-bites often give rise to troublesome sores. Large and repeated doses of opium is the best constitutional treatment; but it may be useful at the same time occasionally to give a brisk purgative.

The second form of destructive inflammation is that with which we have generally to do. If there is pain, opium here again, administered internally and applied locally, is a very valuable medicine.

For the phagedænic form of ulceration without pain, a solution of the potassio-tartrate of iron, in the proportion of ten grains to an ounce of water, is perhaps the most efficacious preparation. The same medicine may be administered internally, in five or ten grain doses, three times a day. The nitric-acid lotion is also very often employed in phagedænic sores. This may be used in the proportion of two or three minims of the strong acid to an ounce of water. The serpiginous sores occasionally defy all treatment. They will sometimes heal after the destruction of the whole of the eroded surface with caustic; but most frequently after being destroyed they will appear to be healing for a time, and then suddenly extend to the same dimensions as before. Within the last two or three years, some cases have presented themselves at the Lock Hospital, which have yielded speedily and permanently to local calomel-fumigation. It is sometimes difficult to say whether a serpiginous sore should be regarded as a primary or as a secondary syphilitic affection. The local calomel-fumigation may then be tried, and if that does not succeed, the general fumigation of the whole body may be employed. One or other of these modes of treatment will relieve almost all intractable ulcerations of a syphilitic origin.

CONCLUSION.

The four varieties of action which have now been described as resulting from the inoculation of the syphilitic poison are quite distinct, although they may occasionally succeed each other.

The first of these is accompanied by the adhesive inflammation, and produces a peculiar chronic enlargement of the inguinal glands, which does not involve the skin or the cellular membrane. This variety is followed by secondary symptoms, and requires, both in its primary and secondary forms, mercurial treatment.

The second is accompanied by suppurative inflammation. It does not affect the inguinal glands. It is not followed by constitutional disease, and requires merely local treatment.

The third is accompanied by the ulcerative inflammation. It produces suppuration, generally of one inguinal gland only, which yields an inoculable secretion. It is not followed by constitutional syphilis, and may be treated by local means.

The fourth is accompanied by mortification. It does not affect the inguinal glands, is not followed by constitutional symptoms, and requires only local treatment.

Each of these four varieties of disease may be simulated during the progress of the secondary symptoms. Secondary effusions of lymph may occur with or without ulceration, accurately resembling the primary infecting sores. Secondary ulcerations may occur on the parts of generation, which may be accompanied by a discharge of well-formed pus (which, however, cannot be again inoculated upon the patient); such ulcerations may, again, be accompanied by suppurating buboes (which do not yield an inoculable pus); or, finally, secondary mortification may take place in either of the forms described. All these secondary affections must be distinguished in practice from the corresponding primary diseases, as the remarks which apply to the former do not necessarily apply to the latter; nor will the occurrence of any one of these affections, as part of the secondary symptoms, at all prevent the progress of secondary disease elsewhere.

HENRY LEE.

TUMOURS.

IT is, perhaps, not possible to define, with a single brief description, the characters which belong in common to all the diseases that are regarded as tumours in the practice of surgery, and that are therefore to form the subject of this essay. They all belong to the class of overgrowths or hypertrophies, and among these their chief and most nearly constant distinctive characters are: (1) that they are deviations, in respect not only of size, but of shape and proportion, from the normal type of the body in which they are found; (2) that they have an apparently inherent power and method of growth, depending on the surrounding parts for little more than their supply of blood-vessels; (3) that their development and growth are independent of those of the rest of the body, continuing, with no evident purpose, when the rest of the body is only being maintained in its normal type.

There are, however, some diseases which, though possessing all these characters, cannot be conveniently classed with tumours: such as some hypertrophies of lymphatic glands, of the thyroid, prostate, &c. To separate Tumours from these, it is generally advisable (though quite arbitrary) to give the name to only those examples of such morbid growths, or growing structures, as are isolated from the surrounding parts by investing layers of tissue; or, although continuous with the adjacent natural parts, are self-circumscribed in the greater part of their extent; or are formed of new materials infiltrated and growing in the interstices of natural parts.

The diseases which may be thus ill-defined as tumours may next be divided into two chief groups, with the names of innocent and malignant tumours,—names which, though they be in some respects faulty, yet may serve to indicate those characters which are certainly the most important in the study of tumours, as objects either of mere pathology or of practical surgery.

The generally distinctive characters of malignant tumours will be enumerated in the essay on CANCER. Those of innocent tumours are: (1) that they are composed of structures resembling, or not very unlike, those of the natural parts of the body, whether in the rudimental or in the perfect state; (2) that their structures are not so mingled or infiltrated among those of the part in which they are seated as to exclude or replace them; (3) that the degenerations and diseases which may occur in them are not prone to extend beyond them; (4) that they very rarely appear capable of multiplying or propagating themselves; (5) that they are usually single, and if more than one be found in the same body they are all in the same part or tissue; (6) that if one be removed, there is little or no probability of another growing in the same or any other part.

To classify innocent tumours, a first division may be made into cystic, or cysts, and solid tumours,—a division which is so far natural that very few specimens will be found which cannot be referred to the one or other group. Then, cystic tumours may be arranged and named according to their contents; and solid ones according to the likeness of their component structures to those of natural parts. Varieties depending on the mixture of two or more structures, or on uniform degeneration, or other change of structure, may be grouped near, and be named with some relation to, the other tumours which they principally resemble. Moreover, among the solid tumours, it is advisable to admit and name the distinction between those which are *discontinuous*, being completely invested with a layer of tissue, isolating them, and connecting them with the surrounding parts; and those which are *continuous* with the adjacent parts, and appear as growths, not in, but of, them. Such are many polypi and pendulous and sessile tumours; and they may be all termed *outgrowths*, while to the corresponding discontinuous and cleanly separable growths the name of tumour may be expressly applied.

In accordance with this general plan, the subjoined classification will be here followed:

I. Cystic tumours; cysts.
    A. Simple or barren.
        a. Serous; hygromata.
        b. Synovial.
        c. Mucous.
        d. Sanguineous.
        e. Oily.
        f. Colloid.
        g. Seminal.
    B. Compound or proliferous.

  - *a.* Complex cystic.
  - *b.* With glandular or other vascular growths.
  - *c.* Cutaneous.
  - *d.* Dentigerous.
- II. Solid tumours and outgrowths.
  - *a.* Fatty; adipose.
  - *b.* Fibro-cellular; areolar; connective-tissue.
  - *c.* Fibrous; fibro-muscular; fibro-elastic, &c.
  - *d.* Cartilaginous.
  - *e.* Myeloid.
  - *f.* Osseous.
  - *g.* Glandular.
  - *h.* Vascular.

Cystic tumours consist essentially of abnormal cysts, sacs, or bags, filled with fluid or other substance produced by secretion or growth from their walls. Some appear to be formed by the increase and coalition of spaces in the connective or other tissues, in which spaces fluid accumulates, and becomes gradually encysted by the definition and more distinct organisation of its boundaries. Such is, probably, the origin of many synovial or bursal cysts, and of some cysts in tumours. But (2) many more cystic tumours are formed by the morbid growth of natural ducts, or sacculi. Such are many mucous, sebaceous, and other cysts. And (3) many are due to the enormous growth of elementary structures which increase from the form of cells or nuclei, and become sacculi with organised walls capable of secreting or producing other growths. If our knowledge of the origin of each form of cystic tumour were much more complete than it is, it would probably be useful to arrange them accordingly. As yet, however, it would be mere guess-work to attempt such an arrangement of those that are of chief interest in surgery. Having, then, thus briefly indicated the general modes of origin, by one or other of which it is probable that all abnormal cysts are derived, the pathology and surgery of each kind may be more fully considered.

Serous cysts, simple and barren, are probably the most numerous of the whole class. The name may include such as have been named hygroma, meliceris, and many forms of hydrocele; and, generally, all the cystic tumours which have thinly liquid or honey-like contents of yellow, brownish, or other tint, not very different in consistence from serum of blood. They may occur in almost any part of the body. By far their most frequent seats are in or near glands or gland-like structures, as the kidneys, the thyroid, the mammary gland,* the labial, and others; but they are not rare in the subcutaneous tissue, especially of the neck and trunk; they may be found too in nerves, in bone, in muscle, &c. In the neck they have been often described as "hydroceles of the neck."

The most frequent serous cysts have their membranous walls, white and moderately vascular, formed of connective tissue, usually too firmly connected with the surrounding parts to be easily detached during life, and generally lined with a tesselated epithelium, or a nucleated membrane. Such serous cysts may be single, or multiple and clustered; hundreds, even, may be collected in one part or place, and may either communicate freely, or be merely collected in one mass of tissue. Their contents may be, and most of them are, like ordinary serum; but they may be thick and honey-like; or may have various tints of green, olive, brown, ruddy, or red; or they may glisten with crystals of cholestearine; or may have fibrine, and coagulate on removal: and as yet no relation or correspondence can be traced between the cyst-walls and their contents; there is no such variety in the former as in the latter.

No general rule can be stated concerning the origin, manner, or rate of development and growth of serous cysts. Of those that are of chief importance in surgical practice, some seem to originate in transformations of the structures of nævi, and are traced to the time of birth or earliest childhood; some, as the ovarian, beginning in enlargement of Graafian vesicles, are diseases of puberty or later life; some, again, as the mammary, are most apt to originate during or after the time of natural degeneracy of the milk-glands. To many others no date at all can be assigned.

For the diagnosis of serous cysts seated in external parts these are the chief facts to be remembered. They are usually regular, well-defined swellings; smooth, round, oval, or, more rarely, lobed; movable with, not in, the surrounding and generally healthy or only wasted parts; painless; covered with healthy integument. Where they are large and not very tensely filled, they may give the sensation of perfect to-and-fro fluctuation; but in many instances, especially in the mammary gland and by the gums, they are so tensely filled, that the detection of fluid must rather be by their admitting of deep central pressure, and instantly recoiling as the pressure is withdrawn. By one or other test of fluid, its presence can be generally ascertained. The diagnosis is made more probable if the tumour that has these characters be in the neck, the mammary gland, or the gums; if, in the first situation, it had its origin in some congenital error; or if, in the second, it was first noticed during or near middle age, or can be partially emptied through the nipple.

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* The special characters of the cysts in each organ will be described in the parts devoted to the surgery of the thyroid, mammary, and other glands, &c.

The diseases most likely to be confounded with serous cysts are the softer kinds of solid tumours, as the glandular, fibro-cellular, soft cartilaginous, &c.; abscesses, especially the chronic; and cystic tumours of other kinds. For help in the diagnosis from solid tumours, the characters related above may be compared with those that will be assigned presently to each kind of tumour; but chiefly the detection of fluctuation, or of the yielding and immediate recoil of fluid, must be relied on. From acute abscess, the diagnosis is usually made clear by the pain, and other signs of active inflammation; from chronic, with more difficulty, by the walls of the abscess being usually thicker, harder, and less pliant, so that the borders feel much denser than the central part. From other barren cysts, the diagnosis may depend wholly on the localities in which they are severally found; but this will be generally sufficient.

The treatment of serous cysts must greatly vary in different cases. Referring here to none but those in external parts, any may be punctured, whether for help to diagnosis or for beginning treatment; but puncture alone is very rarely curative. Some may be cured by external irritation; those in the mammary gland are commonly thus curable, either before or after tapping; with others the same remedy more often fails. Iodine injections are often successful, especially for serous cysts in or near the thyroid gland. Setons may succeed where these have failed, but they are apt to inflame the cyst too much, and with very large cysts may be dangerous. The cysts by the gums are best treated by being widely laid open, and either cauterised within or filled with lint, so that they may freely suppurate. Those in bones may be treated in the same way; and similar means may be used, if milder measures fail, for any that are not too perilous by size or depth. Complete excision is rarely necessary for simple serous cysts, for such portions as may be left will granulate and scar. But if the cysts be multiple and clustered, it is not sufficient to remove some of them: those which are left entire will continue to increase. Hence the occasional necessity of removing a whole mammary gland containing many cysts. The not rare connexion of clustered serous cysts with venous nævi explains the serious bleeding which sometimes occurs during their excision, and which had better be anticipated in operations on those in the neck or near any large veins.

The prognosis of serous cysts is generally favourable. Once closed or cut away, no further mischief is likely to ensue. Yet in some cases great caution is necessary: for, in the breast, a coincidence, apparently accidental, of cystic disease with cancer is not very rare; in the neighbourhood of a large cyst, a small one may be overlooked, and may increase after a seeming cure; and it has happened that a serous cyst, after being obliterated by treatment, has been found to be part of a medullary cancer which its size had concealed.

Synovial cysts. (Diseases of Bursæ.)

Mucous cysts, including all that contain a fluid like mucus, either pure or, as it may be believed, altered by disease or accidental mixture, are commonly derived either from cystic disease of so-called mucous glands, or from dilatation of obstructed ducts or reservoirs. Custom alone has settled which, among diseases answering to this description, should be reckoned among tumours; and the chief are the Nabothian and Cowperian cysts, ranula, and cysts of the antrum. But since all these will be described with the surgery of the parts to which they severally belong, it may suffice to say that, generally, the external characters of mucous cysts are so like those of serous, that the diagnosis between them must depend entirely on the localities in which they are found. Where the one kind are rare, the other are common. For the diagnosis of mucous cysts from other tumours, the rules stated for that of serous cysts will equally apply. As a rule, the sufficient treatment of mucous cysts is to lay them wide open, and then keep them open, or make them granulate: smaller measures are very rarely useful; but particular methods must be adapted to each form or locality. The prognosis is very favourable, for mucous cysts do not appear in the complications with which the serous are sometimes found. They are, however, more difficult to obliterate, and even long after apparent cure may fill again.

Sanguineous cysts (hæmatoceles of the neck, and of any parts other than the tunica vaginalis) are very nearly related to the serous; differing only in their contents, and in that they are usually single, never very numerous in a cluster. They are most frequent in or near the neck or trunk, lying in the subcutaneous tissue, but not rarely extending deep. Their walls may be merely membranous, like those of the most frequent serous cysts; but sometimes they are remarkably fasciculate within, not very unlike the interior of an auricle; and sometimes they have minute cysts in their own substance. The blood in some sanguineous cysts is clotted and partially decolorised, or mixed liquid and clot; in others it is liquid like ordinary venous blood, but coagulates when withdrawn. In the former case, it is probable that the blood is derived from an accidental hæmorrhage into a serous cyst (as a hydrocele may be changed into a hæmatocele of the tunica vaginalis); in the latter case it is probable that the cyst has always contained blood, and has owed its origin to some transformation of the structures of a nævus, such as an enlargement and coalition of its venous canals or spaces. And this view is confirmed by the occasional existence of growths in which blood-cysts and nævus are combined; and of others in which veins are found opening into the cysts.

The diagnosis of sanguineous cysts from solid tumours, and all diseases other than cysts, must rest on evidences similar to those already stated for distinguishing the serous cysts. From these a diagnosis without exploration may be impossible. Both alike may be congenital, or may first appear at any later period; both may be connected with nævi; neither observes any definite rule of increase; neither belongs especially to any one period or condition of life, though both alike commonly come under treatment before middle age.

The treatment of sanguineous cysts may similarly resemble that of serous. Emptying by tapping is rarely successful, but may always be allowed the chance. Iodine or other stimulant injections may be tried; and these failing, the cysts must be laid open or removed, with due care for the free bleeding that may ensue in those that are connected with nævi.

Oily and colloid cysts have too little practical importance to need more of statement than that the former may be found in the place either of cutaneous cysts or of dilated milk-tubes, and the latter in any place where a serous cyst may occur, but chiefly in the thyroid gland and kidney. These may, therefore, be passed by; and *seminal cysts* will be described among diseases of the testicle and spermatic cord.

Compound or proliferous cysts. Under either of these names (but the second is the better) may be included all the cysts on whose walls vascular or other fully-organised structures are formed. The boundary-line between the barren and the proliferous is, of course, not well marked, yet the distinction has some practical utility.

When many simple cysts are clustered together, they may appear like a proliferous cyst: but in general the distinction can be ascertained that, in the one case, the numerous cysts are only contiguous, and in mutual contact at their adjacent walls; in the other case, some are enclosed within others, or are outgrowths from others' walls.

Among the varieties of proliferous cysts, distinguished, as they may best be, by their growths or other products, the chief are enumerated at p. 464. The *complex cystic*, or *cystigerous*, growths are best typified by examples of the complex ovarian cysts, and by the cystic disease of the chorion, the so-called hydatid mole. The general facts which the ovarian cysts illustrate (and no others need be mentioned here) are, that in the walls of a cyst, formed originally in any of the modes in which a simple cyst may be produced, other cysts may be developed. These secondary cysts may grow either immediately beneath the lining membrane of the primary or parent cyst, or in the mid-substance of its walls, or just beneath their external surface. According to their place of origin, such secondary cysts may grow singly, or in thick crowds and clusters, far into the cavity of the parent, or may project on both its surfaces, or grow out external to them. From these varieties of arrangement extreme diversities of form arise; and these are much increased by the repetition of the process in the various production of tertiary and later cysts in or upon the walls of their predecessors. The shapes of the cysts and the structures of their walls are not less various: some are broad-based, low, sessile; others high-raised and pedunculated; others in all intermediate forms; some have thick, tough, laminated walls; some finely pellucid; and the contents of the cysts may be either serous, or turbid and dark, or mucous with various colours and degrees of opacity.

The importance in practice of such varieties of complex cystigerous cysts as are here enumerated is almost entirely confined to those that occur in the ovaries. In other parts they are extremely rare; there are no sufficient signs by which to distinguish them from the multiple or clustered simple cysts, and their treatment must be the same.

Cysts proliferous with vascular growths, including most of the "sero-cystic sarcomata," are most frequently found in or near glands, especially the mammary, labial, thyroid, and prostate glands; but they may be found also in the subcutaneous tissue, and in deep intermuscular spaces.

The walls of these cysts, which may be either single or multiple, are usually formed of thin connective tissue, smoothly lined within, and externally combined closely with the surrounding structures, so that they are not easily dissected out entire. Their cavities, till they are filled with the vascular growths, may contain either serum or any of the fluids that occur in the simple cysts of the same parts. The intracystic growths, according to their duration, or the proportion between the rate of their increase and that of the cyst, fill more or less of the cavity. They appear to spring from single points or spaces on the inner wall of the cyst; thence enlarging and extending, they may gradually fill it, excluding the fluid which at first surrounded them, and then, it may be, uniting with those parts of the inner surface of the cyst from which they did not spring, and coalescing with them so as to form a solid tumour, around which the former cyst-walls appear as a capsule. By still further increase the intracystic growths may protrude through the cyst-walls and their superjacent tissues, and thence may project as "fungous growths," looking like cancerous excrescences.

The form of the intracystic growths is, in different instances, extremely various. Some are low, broad-based, like heaps of granulations; some are very lobed and "cauliflower-like;" some are variously branched with narrow leaf-like processes, clustered and arborescent. Their structures are not less various. Some are soft, yellowish, like laminated fibrine-clot; some spongy and succulent; some are like soft gelatine; some firm, like mammary gland. Again, they are all variable in vascularity, and therefore in their tints of colour; cysts may form in them; they may be diseased or degenerate.

The minute structure of the intracystic growths connected with glands is generally glandular, imitating the structures of the corresponding glandular tumours, but more often than in them very rudimental, or imperfect, or altered by degeneracy or disease. In other parts they appear, generally, like the structures of granulations, and other examples of developing connective tissue.

In the diagnosis of this form of proliferous cysts (sero-cystic sarcoma, cysto-sarcoma), one looks first to their seat. They are not rare in or near glands, or structures beset with glands; they are very rare in any other situations. Their shape is generally roundish or oval, sometimes lowly lobed or tuberous; they are well-defined and movable. If they still contain much fluid, this may be detected by the tension and elasticity of the cyst or by fluctuation; and sometimes the combination of solid and fluid may be detected, as when one feels a hydrocele with the testicle behind the fluid. If there be little or no fluid, the tumour may not be distinguishable from a soft glandular or fibro-cellular growth. There may, indeed, be no distinction possible, seeing that many of the solid tumours thus named very probably originate in such intracystic growths as are here described. The size of the growths will rarely help a diagnosis; they may be of any size, from one just discoverable to a foot in diameter. The structures adjacent to them are always healthy, unless when they have protruded; and then the integuments or other structures, through ulcerations of which they have passed, are not diseased except at the apertures of ulceration. Beyond these there is no thickening or infiltration of tissues; the tumour has not infected the skin, it has only protruded through it. The surface of the protrusion is usually like that of ordinary granulations: florid, soft, elastic, pliant; bleeding easily on contact, yet not profusely. The protrusion of the growth may cause general disturbance or some cachexia: but, except in this case, these tumours are not attended with ill health; and their ordinary history before they come under treatment is, that they have been long observed, increasing slowly and without pain, though it may be with occasional more rapid enlargements.

By all these characters the most important diagnosis of the proliferous cysts—that, namely, from cancer—may usually be made. It may be nearly impossible to distinguish them, on the one hand, from simple or clustered cysts; and, on the other, from glandular or fibro-cellular solid tumours: but this diagnosis is of comparatively little importance. From cancers, especially the medullary, which they most resemble, they must be distinguished by the signs just enumerated; to which may be added the absence of corresponding disease in the lymph-glands and other distant parts.

Excision appears to be the best remedy for all these proliferous cysts. The occasional success of injection of iodine-solutions into ovarian cysts with solid growths, may justify the trial of similar means in some of these cases; but if the trial fail, excision may be at once practised. In the breast, the close adhesion of the cyst to the adjacent structures may require that they should be removed with it: in other parts, the cyst may usually be removed alone.

The prognosis, after removal, is in a large majority of cases favourable. But cases have occurred of repeated recurrence of proliferous cysts in the breast; and this event may be feared when the intracystic growth, and in a less degree the cyst-walls, are particularly soft, succulent, and of gelatinous appearance. The account of cases of such recurrence will be given in the section on recurrent tumours.

Cutaneous cysts. Under this name may be included all those whose walls have the structure, or form any of the usual products, of skin. Some of them, especially those which are congenital and those which grow in the ovaries, have evident cutaneous structures lining them; cutis, epidermis, hair-follicles, &c.: in others, including most of those that have been called sebaceous, epidermal, and atheromatous cysts, there are only such materials as the skin, or some of its included organs, produces.

The cutaneous cysts in ovaries need be mentioned here only as being types of the whole group in respect of the completeness of the cutaneous structure, and the abundance of perfect hair, epidermis, and other structures that they produce. And those that occur in other parts than the subcutaneous tissue have their sole or chief interest in their singularity and rarity. They have been found in the testicle, lung, kidney, bladder, sublingual tissue, and within the skull; in the last situation being probably such as were formed in fœtal life, and shut in by the gradual closure of the ossifying skull. But of all these, no diagnosis or general rules of treatment can be given. Of those that are found in the subcutaneous, or just deeper, structures, it is useful to distinguish the congenital from those that form first in later life.

The congenital cutaneous cysts are by far most frequent under the eyebrow, or in some other position in or near the orbit. They may occur in any other part, but no general account could be given of any but those in or near the orbit. Here they are usually round or oval; often flattened; deep-seated, resting on or imbedded in the frontal bone; and in some cases even prolonged through apertures in the inner wall of the orbit into the ethmoidal cells or the cranial cavity. Their walls are very thin, membranous, white, formed of perfect connective tissue, very closely connected with the textures around them, lined within with perfect epidermis, and often showing hairs like fine eyelashes, growing from perfect follicles. Usually they are filled, but not tensely, with turbid or oily liquid; or with sebaceous or spermaceti-like substance, including cast-off hairs.

Cysts of this kind are usually of slow growth. They increase in the first years of life at a scarcely greater rate than the rest of the body does, and they rarely attain a greater diameter than about two-thirds of an inch; they are usually less. They may, however, enlarge by inflammation, and at last may ulcerate.

By the characters just described, the diagnosis of these congenital cysts is not difficult. The existence of one may be believed in any case of a small growth having the general characters of a cyst, seated near or just within the upper or the inner boundary of the orbit, observed at birth or in early childhood. A nævus may present some of these characters, so may a serous cyst: but the diagnosis of the latter is not very important; and that of the former may rest on its greater softness, compressibility, and pliancy; the bluish tint, or visible blood-vessels, over or near it; its soft puffy feel, its pulsation, or its variable size.

The only appropriate treatment of these cysts is excision; and this is generally to be recommended because they are unsightly, and by displacement of the eyelid or of the eyeball itself may interfere with vision. The depth of the cyst and its close adhesion to all the parts around it, and especially to the periosteum and bone, make the operation and the subsequent healing almost always very tedious. Care should be taken to dissect away the cyst entire: for if its contents escape during the operation, the remainder of the dissection is made much more difficult; and if a portion of it be left, it may continue to produce cuticle and sebaceous matter, and prevent the healing of the wound. Generally, the immediate union of the wound should not be attempted, lest pus form and burrow under the orbicularis muscle. If the removal of the cyst be complete, no return of the disease is to be feared.

The more common cutaneous cysts, which are not congenital or formed in earliest life, have rarely so complete and perfect structures as those just described; only their contents are always like the epidermal or other products of skin, more or less perfect or degenerate. In different specimens the walls of these cysts are widely various. In a great majority they are thin, pliant, formed of healthy-looking connective tissue, loosely connected with the surrounding textures, and lined with smooth shining cuticle. In some they are thick, hard, laminated; in some, toughly fibrous; in some, calcified; but all these conditions are probably due to morbid changes in cyst-walls that were originally thin. In some rare instances, the cyst-walls appear complicated, by the growth of other cysts in or from their walls. Their contents are yet more various, and the varieties have suggested the several synonyms of cuticular, sebaceous, atheromatous, &c. Most commonly they consist of layers of white soft epidermis, easily scaling asunder, disorderly, and mixed with softer or liquid matter at the centre. In some instances, abundant crystals of cholestearine, mingled with the epidermal scales, give a peculiar glistening mother-of-pearl character to the laminæ of the cyst-contents; and many of these have been named cholesteatoma. And in many cases, probably through disease, or through degeneracy of the cyst-walls, the contents consist of turbid brownish, yellowish, or other coloured fluids, in which clusters of epidermal cells, with granular, earthy, and fatty matter and crystals are floating. But however strange the contents may seem, the microscope will always detect in them true epidermal structures; nucleated scales, filmy and folded, lying in clusters, or free, or collected in the form of laminated capsules (like those which some have thought characteristic of epithelial cancer). Often, too, the smell of cutaneous secretion is as evident as the sight.

The cutaneous cysts may be found under the skin of any part; but they are probably a hundred times more common in the scalp than in any other situation. Some of them have, in the skin over their chief prominence, a small dark point, through which a fine probe may be passed into their cavity; over others no such mark can be seen. And this difference indicates a difference in their modes of origin; namely, that the former are due to distension and overgrowth of hair-follicles, whose orifices remain obstructed by the material of the dark point; and the latter are complete cysts, formed, it may be, after the fashion of hair-follicles, but having never contained hairs or possessed external openings. In either method the cysts are usually first formed in youth or early adult age, though they rarely come under treatment till many years later. They are very rarely referred to any local cause, but are commonly hereditary, though not connected with any constitutional peculiarity. Their rate of growth is uncertain. Many, after attaining a diameter of about half an inch, remain long or always stationary; others, even in the same person (for these cysts are often very numerous in the scalp), maintain a regular rate of increase, and thus some have reached a diameter of six inches. But when they grow very rapidly, or when they are actively inflamed, as after injury, it is common to find cutaneous cysts very thinly covered with ruddy or dry skin; and this, ulcerating, may permit them or their contents to protrude. Hence are derived most of the so-called "horns" of the scalp and face, and more rarely of other parts. Sometimes, too, it has happened that the protruded contents of an inflamed and ulcerated cyst have become vascular, grown rapidly, and formed a granulated bleeding mass, very like an exuberant epithelial cancer.

In the scalp the diagnosis of cutaneous cysts is rarely difficult. In other parts it may be difficult to distinguish them from chronic abscess, fatty or fibro-cellular tumour, acephalocyst, or any softish tumour. The chief points to be looked to, in addition to those that are common to all cysts, are their immediately subcutaneous situation; their regular, smooth, round or oval form, which may in some instances be made to change by pressure, when the contents are a soft substance that may be moulded into various shapes; the easy mobility; the dark central point; the hereditary origin; the slow growth; the healthiness of the immediately surrounding parts.

The cutaneous cysts admit of several modes of treatment. Those that have the minute openings may be gradually emptied by dilating their openings and pressing out their contents; and being thus treated, they may be kept from being unsightly or otherwise troublesome, or may shrivel up and disappear. But if this treatment fail, or if there be no opening, and if either the size or any of the inconveniences of the cyst make their removal desirable, they may be extirpated with caustic or the knife. The latter alone might be advised, if it were not for the peril of erysipelas and other mischiefs that attend even minor cutting operations in some persons. Few surgeons of large experience have failed to see one or more deaths after the excision of cutaneous cysts, especially of those in the scalp. Whenever, therefore, there appears any appreciable, or more than average, risk of such a calamity, the caustic treatment should be employed. A space of half an inch or less in diameter over the most prominent part of the cyst being thoroughly cauterised with nitric acid or potash, the separation of the slough will lay open the cyst, which may then be left to empty itself and wither; or may be drawn out through the opening; or may be emptied by pressure and cauterised within. Or, in another method, the cyst being first punctured, its interior may be cauterised, and it will slough out.

When excision is to be practised, it is not necessary or usually advisable to dissect round these cysts. Their connexions with the tissues next to them are generally so loose, that if they be freely cut into, they may be seized at their cut edges and pulled out through the corresponding incision in the skin. This may be impossible if the cyst have been inflamed, or become adherent by the changes induced by friction,—changes which are chiefly frequent with those on the trunk and limbs. It may then be necessary to dissect out the whole cyst; or, if it have protruded, it may have become so adherent to the surrounding skin as to require a small portion of this to be removed with it.

Cysts containing teeth are of two kinds. Some, found in the ovaries, or, much more rarely, as congenital growths, in other parts, contain, with one or more teeth, the products of skin, as hair, epidermis, &c. Others, occurring in the jaws, appear to be enlarged tooth-capsules, in which the teeth, through defective or erroneous development, have not been extruded. The former will be best considered among the diseases of the ovaries; the latter among those of the jaws.

Fatty or adipose tumours and outgrowths are the most frequent of all innocent tumours. They are commonly described under the names *lipoma* and *steatoma*, and afford good examples of the two modes of growth, continuous and discontinuous, already indicated (p. 463).

The continuous, or fatty outgrowths, commonly appear as lumps of fat in the subcutaneous tissue, ill-defined, having no definite boundary, as if the ordinary fat of some one part had increased beyond all natural proportion to that of the parts around. The excessive double chin that some persons have is a growth of this kind; and others, more evidently morbid, and more rare, occur especially at the nape, or behind the ears, or over the lowest cervical vertebræ. They do not differ in structure from the ordinary fat of the adjacent parts, unless in being rather firmer; they are generally troublesome only by their ugliness; yet some patients complain of pain in and about them.

No good cause can be assigned for these hump-like outgrowths of fat. Once only the writer has seen one in a child whose father had one in the corresponding place—the lower part of the back of the neck. Generally they begin their growth in persons about forty years old, and slowly increase, till, attaining some uncertain size, they stay thereat. They appear not more liable to degeneration or disease than is the natural fat adjacent to them.

There is very rarely any difficulty in the diagnosis of these fatty outgrowths. They are evidently only too much subcutaneous fat in a certain place. And generally they are hardly amenable to treatment. Sometimes they may be cured by the long-continued taking of liquor potassæ; but if this fail, excision alone would remove them; and this is rarely advisable, for the scar of the operation would be as ill-looking as the growth.

Fatty tumours, properly so called, are far more common than these outgrowths. Their most frequent seats are the trunk, especially about its upper half, and the parts of the limbs nearest to it. The further from the trunk, the more rarely they appear; they are exceedingly rare in parts that do not naturally contain any adipose tissue; but, with the rarity of curiosities, they may perhaps be met with any where. They usually lie in the subcutaneous fat, upraising the skin, and connected rather more closely with it than with any other of the tissues next to them.

Among fatty tumours, some are much firmer than others, and than the normal adipose tissue; and the firmer (to which Müller gave the name *lipoma mixtum*, and others *steatoma*) are usually smooth, round, or oval, or very largely lobed. These have generally tough investing capsules, from which partitions, extending inwards, intersect them, and make a kind of close brawny mesh-work filled with fat-cells. The firmer fatty tumours are, probably, more often deep-seated than subcutaneous; especially they seem apt to grow near joints; but they are altogether much more rare than those of the softer kind. These, which are the common fatty tumours, resemble in their minute structure, with scarcely a difference, the natural adipose tissue. They are generally of a somewhat round or oval shape, flattened if they lie with little prominence between the skin and fascia; pyriform if they are pendulous. Commonly they are deeply lobed, and large outlying lobes sometimes extend from them, and dip far into the adjacent fat, or, rarely, through the fascia into intermuscular spaces. They are always invested with a thin, dry, fibro-cellular capsule, isolating, and yet connecting them with the surrounding parts, especially the skin; and partitions extending from the capsule separate their lobes. Their principal blood-vessels ramify in the capsule before passing to the lobes; and are most frequently derived from one or two trunks rising from vessels beneath the tumour. The laxity of the capsule often permits a fatty tumour to shift or slide from the place of its first growth to one lower down. Thus, one beginning in the groin may shift down the thigh; or from the perineum, one may pass into the scrotum: facts of great use in diagnosis, since such changes very rarely happen with other tumours.

Fatty tumours come under treatment in young persons, and adults of all ages. They are very rare in children, but not rarely begin to grow in youth, though, growing slowly, they may be overlooked for many years; they may begin to grow at any later age, but very seldom appear first in old age. They are sometimes assignable to local causes, as a blow, or, more commonly, frequent friction, as by a strap or band over the skin. Sometimes, too, they have so appeared after fever or some general illness, as to seem due to a constitutional cause. But, in a majority of cases, no good cause whatever can be assigned; and they very rarely seem to be hereditary. From the first they present a perfect adipose structure; no changes of development are known in them. Their growth is commonly very slow, sometimes fitful, very rarely rapid; but, though slow in growth, they may grow long enough to attain an enormous bulk; some have weighed fifty pounds. They are usually insensible, yet are sometimes referred to as the centres or causes of vague radiating aches and pains. After injury, or sometimes spontaneously, they may inflame or degenerate. Of this, the most frequent consequences, and the most important to be remembered in diagnosis, are, central collections of serum or pus, or some glutinous fluid in a cyst; central nodular induration or calcification; sloughing or ulceration of the superjacent skin, and exposure of the tumour, a result which is especially likely to happen with such as are pendulous.

In a great majority of cases fatty tumours occur singly; yet instances are not rare in which large numbers of them appear in rapid sequence in the subcutaneous tissue of the limbs (especially the arms) and trunk, all slowly increasing, till—after attaining about an inch, or rarely more, in diameter—they usually cease to grow. Their multiplicity and general limitation as to size are the only characters distinguishing the tumours in this singular form of disease. In the times and conditions of life in which they may first appear; in the absence of all evident constitutional disease; in their varieties as to degree of firmness and amount of intersecting connective tissue; and in every other respect, they are exactly like the more common single fatty tumours.

Little need be added to the foregoing description to indicate the diagnosis of a fatty tumour. A firm deep-seated one may be not distinguishable from a fibro-cellular or fibrous tumour; but this is of little importance: it is enough to make out, by the uniform firmness, elasticity without fluctuation, mobility, smooth, regular, or largely-lobed shape, by the slow growth, and freedom from pain, that the tumour is not a chronic abscess, cyst, bursa, or firm medullary cancer, but an innocent tumour, proper, if required, to be removed.

The diagnosis of the common subcutaneous fatty tumour is much more easy, and will seldom be missed if it be observed that, with most of the characters indicated above, a tumour feels soft, pliant, 'pillowy,' easily movable, and that, by compressing its base and borders, so as to make the skin tense over it, the skin presents dimples corresponding with the spaces between its lobes. Pendulous fatty tumours can be confounded with none but pendulous cutaneous growths; and the diagnosis is difficult but unimportant. The consequences of inflammatory and other changes will not make the diagnosis harder than usual, if the probability of their occurrence be kept in mind. Multiple fatty tumours have nothing like them, except the neuromata or fibrous tumours that sometimes occur in great numbers in subcutaneous nerves; but these are generally much firmer, more variable in size, often painful, and are associated with other and deep-seated tumours.

Only one method of treatment, excision, is applicable to fatty tumours. It is to be recommended for any that are unsightly, or inconvenient by their bulk or hindrance of movements, or increasing so quickly that delay of the operation will materially augment its extent. In the excision it is usually sufficient, and advisable, to cut fairly, with a single median incision, into the tumour, and draw or scoop it out by splitting the capsule that loosely invests it. In the case of the multiple fatty tumours, removal is very seldom to be advised, unless for any one that may grow very far in advance of the rest. With those that are pendulous, all the covering skin should be cut away, except so much as may be necessary for flaps to close the subcutaneous part of the wound.

The prognosis of fatty tumours is most favourable. They may be removed with as little danger as attends any cutting operation whatever; they never return after removal; and in cases in which, for any reason, small portions have been left in operations, they have not resumed a progressive growth.

Fibro-cellular tumours and outgrowths are such as consist entirely, or chiefly, of tissue resembling the ordinary cellular, areolar, or connective tissue of the natural structures. In different specimens the tissue may be more or less embryonic or perfect, more or less delicate, or firm and tough, succulent or dry; or other tissues, as the fatty, elastic, or even glandular, may be mixed with it; but, in all these respects, the tumours scarcely exceed the differences which exist among different examples of the natural structures referred to the cellular or connective tissue in their various conditions of development or disease.

The most frequent of the outgrowths are found in the softer kinds of polypi, and in the pendulous growths of skin. These will be described in other appropriate places (NOSE, EAR, SKIN, &c.); but it may be observed of nearly all the so-called mucous or gelatinous polypi, that a very large part of their substance is composed of gland-structures; and of the cutaneous outgrowths, that not the fibro-cellular tissue alone, but all the component structures of the skin, are usually together, though not equally, increased.

Fibro-cellular tumours are among the rarer forms. Their most frequent, but not exclusive, seats are the deep intermuscular spaces of the limbs, the scrotum, labium, or by the wall of the vagina, and (in the form which most closely connects them with the fibrous tumours) in the subcutaneous tissue. Their typical characters are best marked in those removed from the limbs, scrotum, or labium. They are usually oval or round, more or less deeply and largely lobed, invested with thin capsules of connective tissue, by the splitting of which they may be each separated or enucleated from the adjacent parts (a character by which those of the genital organs are at once distinguished from the cutaneous outgrowths and hypertrophies of the same parts). To the touch they are firm, tense, and elastic, very like tough-walled cysts tightly filled with fluid. On section they usually present a shining, pale-yellowish, or serous-coloured basis, intersected by opaque white bands, moderately firm, succulent, and very elastic. The intersecting bands or marks are curved, but with no regular plan, and give no distinct fibrous appearance to the section. At first sight many of these tumours, soaked as they are, or, as it were, œdematous, with yellow serous fluid, look like fat; but when left at rest, or suspended, the fluid oozes from them, and their tissue contracting becomes firmer, whitish, and opaque.

In microscopic examination the fibro-cellular tumours present the same elements as the similarly named natural tissue, but, usually, with a larger proportion of them in a rudimental form. Generally there are, or appear, abundant fine colourless filaments in undulating bundles, variously interlaced or matted; and with these, are various proportions of nuclei, and of fusiform or caudate, or stellate nucleated cells, such as may be found more abundantly in granulations, or in the softer kinds of connective tissue, in which the connective-tissue-corpuscles are most abundant. Occasionally, very soft examples of the tumours are met with, in which these corpuscles predominate over the filamentous tissue. In most instances, the elements of connective tissue are alone found in these tumours; and their varieties depend on the degrees in which these elements are developed, or variously compact, or infiltrated with fluid. Elastic yellow tissue is very rarely seen; a singular fact, if the almost constant presence of that structure in the natural connective tissue be considered. But, occasionally, nodules or thin layers of cartilage or bone are found, either imbedded in, or encasing, the mass of the tumour, adding not a little to the difficulty of the diagnosis.

The origin of a fibro-cellular tumour is very rarely to be traced. They are so seldom referred to violence, inheritance, or any general disease, that when they do seem to have such an origin, it is, probably, only by a chance-coincidence. They may begin to grow at any period of life, but they do so most rarely before adult age, and most frequently at middle or older age. Their rate of growth is variable, but sometimes very rapid, as much as three or four pounds in the year; or even, as the writer saw in one case (which, however, was an instance of recurrent tumour), at the rate of a pound per month.* Thus, or more slowly increasing, they may attain a weight of forty or more pounds, especially in the scrotum, whose texture offers them the least resistance, and, by its extensibility and quick growth, the best protection. The extreme distension, however, which such tumours cause, often leads at last to sloughing or ulceration of the integuments over them, especially at their lowest or most dependent part. The ulcer, in these cases, presents no specific characters; and the tumour usually only lies exposed at its base, without protrusion; but the purulent discharge and increased irritation to which the change gives rise, being added to the burden of a huge tumour, may prove fatal. The tumour may partake of the changes of the parts over it, becoming inflamed, soft, or sloughing; but in these changes resembling only the ordinary connective tissue, when similarly diseased. Except in these morbid states, the ordinary fibro-cellular tumours are very rarely painful.

The statements just made respecting rapid growth, sloughing, and ulceration, apply to the fibro-cellular tumours of the external genital organs, much more than to those of any other parts. And corresponding differences must be had in view in making a diagnosis, during life, of any example of this form. In the scrotum, it may be difficult to diagnosticate a fibro-cellular tumour from some disease or growth in the testicle; and here the chief point to be looked to (in addition to those already mentioned in the description of the tumour), is the separateness of the testicle from the new-formed mass. If the testicle be free, the nearest likenesses are in large omental herniæ; in fatty tumours in the scrotum; in hydroceles; in elephantiasis scroti. It must suffice to enumerate these, for no single sufficient ground of diagnosis can be stated; and the discrimination must, in each case, be made by comparing the characters of the disease under examination with those of each of the several diseases above named. So also with fibro-cellular tumours in or near the labia; the diagnosis is to be similarly made from large labial herniæ, from Cowperian cysts, from fatty tumours, and from cutaneous outgrowths. In the subcutaneous and intermuscular tissues, the most nearly similar diseases are chronic abscess, hydatid, and the several forms of tumours of the softer kinds, as the fatty, cystic, medullary, and others. The diagnosis of a fibro-cellular tumour from any and all of these may be sometimes made by looking closely for the characters assigned above to it; but more often, no better conclusion can be arrived at, than that the tumour under examination is one of some two or three of the kinds named above. Happily, a nearer diagnosis is rarely important, since all these confusible swellings are such as may properly be cut out or cut into.

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* It should be mentioned, however, that in these, as, in a less degree, in other tumours, there may be much increase of size without so much growth; for their bulk may be augmented by serous infiltration, or inflammatory deposit, or other causes of mere *swelling*, without growth.

Excision is the only proper treatment of the fibro-cellular tumours, and it is to be advised in nearly every case, unless in those of old people, in whom the growth has attained such a size that its removal would be too dangerous to life. What has been said of the excision of fatty tumours might be repeated here; and so might the statements as to the very favourable prognosis after removal; but with this reserve, that if a fibro-cellular tumour be very incompletely developed, soft, looking like little more than size or other soft gelatine, or presenting a great preponderance of its elemental structures in an embryonic state, it is likely to prove recurrent.

Among the most remarkable tumours formed of fibro-cellular tissue are some of those named "painful subcutaneous tubercles." But inasmuch as the pain, which is their chief characteristic, may exist with tumours of other structure, there will be some practical convenience in describing them at the close of the essay.

Fibrous tumours and outgrowths are among the most common kinds, including, as they do, those that are so frequent in the uterus, and others in which the fibrous is the most abundant but not the only tissue. Among the various names (desmoid, chondroid, tendinous, fleshy, and others) by which they have been described, 'fibrous' may be chosen as implying their general likeness to the natural fibrous (tendinous or ligamentous) tissue; and where other tissues are combined with it, their presence may be indicated by compound names, as fibro-muscular, &c.

The fibrous outgrowths or polypi of the uterus, nose, pharynx, and other parts, will receive sufficient illustration in the essays on the surgery of the several organs they affect.

The most frequent seats of fibrous tumours are the uterus; the bones, especially of the jaws; the nerves; the subcutaneous tissue; the cellular tissue near joints, and many sheaths of tendons; the testicles; and the lobules of the ears. In all situations they tend to the rounded, oval, or true spherical shape, but adapt themselves perfectly to the shapes or resistances of the parts around them. Except in the uterus, and when connected with the jaws, they are rarely lobed. They usually are distinctly invested with a thin capsule, which, except in the nerves and bones, may be easily split; but those that grow on the exterior of bones are firmly connected with them, less or not more easily separable than is periosteum, and appearing, indeed, more like overgrowths of periosteum than like the distinct fibrous tumours of other parts. Their substance is usually very firm, resistant, elastic, tenacious, in some specimens intensely hard; in some, but probably through decay or inflammation, softer, brittle, œdematous.

On section, the fibrous texture is, in different specimens, variously marked. In some, curved, shining, white bundles of fibrous aspect traverse a more homogeneous basis-substance of grayish, yellowish, or dull-white colour; in some, such bundles affect a kind of concentric plan, like that of an intervertebral fibrous disk; in some, bundles much less regular and distinct are, as it were, closely fitted together; in some, the whole section looks nearly uniform, pale or white, very dense; and the fibrous structure, though discoverable with the microscope, is not visible to the naked eye. In agreement with their other resemblances to the natural fibrous tissues, these tumours are very lowly vascular, though, when inflamed, capable of a greatly increased supply of blood.

The microscopic examination of fibrous tumours finds a close imitation of the natural tissue in their fine, stiff, undulating filaments, or filamentous appearance. With these, nuclei, or elongated cells, or other probably rudimental or developing structures, are usually found. And, in many instances, other tissues appear which the unaided eye could not discern. The fibrous tumours of the uterus display smooth muscular fibres, like those of the uterus itself, proving their homology with it, and suggesting that they should be called fibro-muscular, or uterine, rather than fibrous. So, many of those of the subcutaneous tissue have elastic fibres; and some present mixtures of cartilage or of bone.

In the history of fibrous tumours, their origin usually appears spontaneous; that is, it is unknown. They may sometimes be referable to injury, but, except in the case of those that follow borings of the ear (which probably partake of the nature of cheloid disease), there is no general rule; and even when they can be traced to injury, there is no knowledge how or why the growth ensued. Their increase is usually slow in comparison with that of fibro-cellular tumours, and, since their growth seldom affects the adjacent parts so much as to interrupt their due and probably very slow nutrition, they may increase to an enormous size. Some, in the uterus, have been more than seventy pounds in weight. Generally, they grow uniformly, and without pain, unless they involve some sensitive part; and their growth, if not interfered with, is rarely attended with any cachexia or other constitutional disturbance; enormous fibrous tumours of the uterus are sometimes borne for years with no other damage than that of the burden. Accidents, however, may disturb this usual innocuity. If a fibrous tumour be inflamed, it may become very painful; may soften, or decay, and be excavated: if near the surface, it may give rise to ulceration of the integuments over it, may protrude and bleed even profusely. (With those of the uterus many other troubles may arise, which will be described elsewhere.) Besides these active changes in fibrous tumours, others of much slower progress may occur, of which the chief are the formation of cysts and calcification.

The cysts in a fibrous (or, as it may be called, "fibro-cystic") tumour may be numerous, small, and scattered through its substance (this is frequent in those of the testicle), or one of large size may occupy all the mid-substance of the tumour, giving it the appearance of a thick-walled serous cyst, and admitting of similar treatment. Fibrous tumours thus changed have been found in the uterus, and more rarely in the lower jaw. Calcification is at present known only in the uterine tumours, and its chief importance is, that it indicates arrested or extremely retarded growth.

In all parts but the nerves and the uterus, in which there is no limit to the number that may grow coincidently, fibrous tumours are single.

The best marks for the diagnosis of fibrous tumours (excluding those of the nerves, testicle, and uterus, treated of elsewhere) are, their regularity of shape, or their being moulded to surrounding parts; their uniform firmness or hardness; their generally slow growth, and freedom from pain; the healthiness of the textures round them. To these characters may be added, for the diagnosis of fibrous tumours of the subcutaneous tissue, their mobility; their non-adhesion to the cutis, unless they be nearly ulcerating; their protrusion, and frequent bleeding when ulceration has taken place. In this tissue, the diseases with which a fibrous tumour is most likely to be confounded are, a single cancerous tumour, an indurated lymph-gland, a very tense cyst with thick walls, an unusually firm fibro-cellular or recurring fibroid tumour. From these last two a diagnosis before excision may be impossible. In the deeper parts, as near joints and by sheaths of tendons, the same general characters may serve for diagnosis; the most similar diseases being very tight and hard bursal or ganglionic swellings, firm medullary cancers, cartilaginous growths within or on articular capsules, or near the heads of bones.

On or within bones, the diagnosis of fibrous tumours is scarcely to be made, except at the jaws, where alone they are not extremely rare. A growth resembling a fibrous tumour, connected with any other than a jaw-bone, is most likely to be either cartilaginous, myeloid, or a medullary or osteoid cancer. Those of the jaws may grow either on the surface or within the bone. Among those on the surface are the most frequent examples of epulis. Their best diagnostic signs are, their being hard; having the alveoli for their chief base of attachment; shaped to the mouth and other jaw; often comparatively narrow-based; slow in growth; painless; covered with healthy mucous membrane; or, if ulcerated, having no specific form of ulcer; not associated with any serious disease of the adjacent parts, nor, even when of long duration, with any cachexia or disease of lymph-glands. By these characters the fibrous tumour on either jaw may be distinguished from medullary and epithelial cancerous growths, and from myeloid tumours, and periosteal swellings,—the only diseases likely to be confounded with them. And, lastly, for the diagnosis of fibrous tumours growing within and expanding either jaw-bone, the chief points to be looked to, in addition to those already indicated, are, their slow growth; the healthiness of the covering tissues, especially of the gums; the absence of signs of infiltration of the disease into adjacent bones, which, though they may be displaced, are not overspread. These signs may suffice for the diagnosis from cancerous tumours; but so long as the growth is not sufficient for a great expansion of the jaw, and for such thinning of the walls as may permit the detection by tact of the nature of the material within them, it may be scarcely possible to make a diagnosis between a fibrous tumour and a dentigerous or other cyst, or any other non-malignant interior or substantial growth.

The diagnosis of a fibrous tumour in the lobule of an ear is easy; cysts alone are likely to be confounded with it.

In the treatment of fibrous tumours (not including those of the uterus), excision is the only available remedy, and had better be resorted to without delay. The method must vary according to the seat of the tumour. Simple enucleation is rarely possible in those within the nerves, bones, or lobules of the ears, though in the first two it may be very often worth attempting, for the obvious advantages that would attend success. In the removal of those that grow on bones, the base from which they spring must be removed with them; and the probability of their dipping into alveoli or other cavities must be remembered.

After the complete removal of a fibrous tumour, recurrence is not at all probable, except in the case of those of the ear-lobules, which, as already stated, seem to partake of much of the nature of the cheloid disease of scars. But, before promising future immunity, the diagnosis from recurring fibroid tumour must be made sure even after excision; and this surety may not be obtainable without microscopic help. Moreover, cases have occurred, though in extreme rarity, in which fibrous growths have presented every character of cancerous disease except that of structure: recurring; infiltrating adjacent parts; growing in distant organs; destroying with cachexia. It is a question of words whether these should be called 'malignant fibrous tumours,' or 'fibrous cancers;' and the question is dependent on another, namely, whether the structure or the characters of life should have precedence in determining the names of morbid growths.

Cartilaginous tumours, or *enchondromata*, as they are almost as frequently called, occur most commonly in connexion with the bones; but they are not rare in the substance or neighbourhood of the parotid gland, or in the testicle; and they may be found as curiosities in many other parts. Growths of cartilage, pendulous, or loose in joints, have also many characters in common with cartilaginous tumours; but their peculiarities predominate enough to justify their separate consideration.

The general characters of cartilaginous tumours are, that they are irregular, or, if of any definable shape, rounded or oval masses, which, if not restrained by resisting surrounding structures, have very generally well-marked prominent lobes or outstanding smooth nodules. Usually, they feel every where hard, resisting, scarcely compressible; but when compressed, they give the sensation of very quick elastic recoil. Rarely they are soft and compressible, but still very elastic. On those parts which are not attached to or enclosed in bone, they are invested with tough fibro-cellular tissue, that serves them as a perichondrium, and this is again connected with the surrounding parts by similar tissue of much less compactness and peculiar dryness. The parts around a cartilaginous tumour are usually quite healthy; no growth seems to be more readily tolerated, or to displace other structures with less offence or injury to them. Only, if there be much friction between a cartilaginous tumour and the parts next to it, a bursal sac is commonly formed between them. When they grow within bones, the compact osseous tissue grows as a shell around them, with no intervening tissue, firmly but not inseparably adherent.

On section (and the sensation of cutting them is generally quite characteristic), a cartilaginous tumour may appear as a single mass, imperfectly partitioned; but as often it is like a cluster of tumours, separated by their several investing layers of connective tissue, though enclosed in a common covering. In either case, the most frequent appearance of the cartilage is like that of ordinary fœtal cartilage; bluish or yellowish-white, smooth and glistening, close, uniform, without appearance of granular or fibrous texture. Some specimens, however, without appearance of disease, are soft, almost diffluent; some are fibro-cartilaginous; some look granular; some are opaque or creamy-white; some are varied by partial ossification; some by degeneracy or disease, in ways that will be presently described.

The microscopic characters of cartilaginous tumours are even more various than those which appear to the naked eye; but as yet it is seldom possible to connect the one with the other, very different appearances of minute structure being often found in different, and not evidently dissimilar, parts of the same specimen. It may suffice to say here, that in well-marked typical examples of the tumour the minute structures are, in all essential respects, like those of natural, preparatory, or ossifying cartilage, or fibrous cartilage of the least firm kinds; but that in other specimens, or even in parts of those that are typical, there may occur any of the singular varieties of minute structure which may be found in natural cartilages in their several stages of early development or in their arrests, as in rickets, or in the perversions of disease. Among these are remarkable examples of cells with stellate and various processes, in forms that are common to both the connective tissue and cartilage in a rudimental state.

The origin of cartilaginous tumours is sometimes by inheritance, and sometimes is referable to injury; but neither of these sources is frequent enough to help in diagnosis, unless in the case of the cartilaginous tumours of bones. With the exception of those growing in the bones of the hands, they are usually single tumours. Those of the bones most commonly begin their growth in early life; some, on the hands, in infancy; others, more often, between childhood and puberty. Their beginning in later life is, however, not very rare, even on the bones; and in other parts they most commonly begin in full adult or middle age. Exceptions to these general rules are, unfortunately, frequent enough to detract from their value in diagnosis; but it may be generally held that the younger the age at which a tumour of bone begins, the more is it likely to be cartilaginous, if its general characters agree therewith.

Their rate of growth is entirely and inexplicably uncertain. Their histories would tell of increase, in some instances as rapid, in others as slow, as could be told of any of the most different tumours. Most frequently, indeed, they increase slowly; but the rule is too uncertain for diagnosis. So is the size they may attain; some have grown to enormous dimensions; for instance, two feet in diameter; others have gradually and slowly increased to less than an inch; but both these extremes are rare.

Coincidently with growth, ossification of a cartilaginous tumour may go on; or rather, while one part of the tumour is growing, another may be ossifying; and if, as often happens, the ossification be more rapid than the growth, the cartilaginous tumour may become wholly osseous. Such ossification is most frequent in cartilaginous tumours rising from bones, and is usually effected by the growth of bone, like an outgrowth or process from the wall of the natural bone on which the tumour is fixed. Thus, the most frequent condition in which such tumours are found, is that of having bases or stems formed of cancellous bone, and covered with a mass or crust of cartilage. In the cartilaginous tumours that grow within bones, and in those of the testicle and other soft parts, the ossification is usually very sparing; only scattered little pieces of soft bone are found in them; but these are sometimes arranged as so many nuclei or centres of ossification, one for each constituent lobe or nodule of the mass.

By degeneracy, or defective development, or, still more, by disease, the characters of a cartilaginous tumour may be so altered as to make its diagnosis extremely difficult. The chief condition thus arising is a softening or liquefaction of the cartilage, so that nodules of it present central cavities filled with fluid, like honey, synovia or serum, or with semifluid jelly-like substance; or a large tumour may be excavated, and its central part may be occupied with these soft or liquid materials, round which its solid part remains like a thick nodular cyst. The nature of this change is uncertain; perhaps, indeed, in some cases, that which looks like softened or liquefied cartilage is a material arrested in a rudimental state, which had never been developed into natural firmness; but, generally, softness coincides with rapid increase of the tumour. With active inflammation the substance of a cartilaginous tumour may rapidly soften, as if with decay and suppuration. Thus, some are found excavated, with cavities full of purulent fluid and débris; and some, forming adhesions to the skin, may ulcerate and protrude. But even in this state they rarely bleed largely.

To the numerous varieties of appearance which may thus be presented by cartilaginous tumours, those must be added which are due to their being mixed with growths of wholly different kinds. No 'mixed' tumours are so frequent as those of which cartilage forms part. Thus, nodules of cartilage are not very rare in fibro-cellular tumours; the cartilaginous tumours in or near the parotid gland have commonly an intermixture of glandular tissue; many of those in bones are mixed with myeloid structure; and, in the testicle, cartilage and medullary cancer have often occurred in an apparently single tumour.

The varieties just described interfere with general rules for the diagnosis of cartilaginous tumours; yet some may be stated. When they are not encased in bone, or in unyielding tunica albuginea, they may be almost always known by their extreme hardness, their peculiarly round or nodular surface, and their quick resilience if they can be compressed. Their hardness may be equalled, though not resembled, by that of scirrhous cancer, of bone, and of a calcified structure; *e. g.* a lymph-gland filled with calcareous matter. But cartilaginous tumours are so exceedingly rare in the breast, and single scirrhous cancers are so equally rare in any other external organ, that doubt between these two diseases can scarcely ever arise. The difference in kind of their several hardnesses will distinguish cartilage and bone, unless there be much thickness of soft parts over them; but, indeed, in any case in which a doubt exists, it is probably not important whether the tumour be cartilage or bone, or a mixture of the two. And, for the diagnosis between a cartilaginous tumour and an indurated or calcified gland, it may usually be found in that one does, and the other does not, grow.

Next to these signs for diagnosis, the most important may be the situation of the tumour. If it be in or upon the parotid or submaxillary gland, and possess the tangible characters of a cartilaginous tumour, pure or mixed, in but a moderate degree, the probability of its being such a tumour is very great. The other diseases likely to imitate it are simply enlarged lymph-glands, or cancer in the parotid or in its lymphatics. The diagnosis between the first and a cartilaginous tumour can scarcely be difficult; from the second and third, one may be most generally known by its special form, not taking that of the salivary gland itself, by its singleness, and its slow growth (for in this region cartilaginous tumours do not at all equal cancers in their rate of increase).

The diagnosis of cartilaginous tumours of the testicle and in connexion with bones will be treated elsewhere.

In the treatment of cartilaginous tumours, removal is the sole remedy; but its method must vary with the seat of disease. In the parotid region enucleation is often unexpectedly difficult, because of the close adhesion of the capsule of the tumour to the surrounding parts, and through the proximity of branches of the facial nerve, and the frequent dipping-in of lobes of the tumour to deep regions. The difficulty, if foreseen, is very rarely insuperable; but if any small portion of the tumour cannot be safely removed, it may be left with a good probability that it will not increase. For the tumours of the testicle enucleation is not to be thought of; but for those growing within bones it is more often practicable than practised, and may frequently be adopted; but on this point also see the essay on DISEASES OF BONES.

The prognosis of cartilaginous tumours after removal is generally very favourable; but some exceptions must be made. Such as are very soft may be recurrent; such as are mixed with cancer do not prevent the ordinary progress of the cancer: it affects lymphatics and distant organs, just as if no cartilage had existed with it in its primary seat. And lastly, one case, recorded by the writer, has shown that a cartilaginous growth may pass into lymphatic vessels (probably by penetration of their walls), and extending along them into a vein, may yield to the flowing blood materials from which cartilaginous tumours may grow abundantly in the minute branches of the pulmonary artery.*

Myeloid tumours are distinguished by their containing or being chiefly composed of minute structures, similar to those of fœtal marrow or diploe. Unlike the cartilaginous tumours, in which the resemblance to fœtal structure exists alike in the plainly visible and in the microscopic appearances, these have no distinct resemblance to fœtal marrow in their general characters, though with the microscope the homology is evident.

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* *Medico-Chirurg. Trans.* vol. xxxviii. p. 247.

The myeloid tumours affect especially the bones; and it is not yet certain that they ever occur as primary growths in any other structure; though tumours much like them have been found in the breast and other parts. At any rate their general characters must be described after specimens connected with bones.

Like the fibrous and cartilaginous, a myeloid tumour may grow either within a bone or on the surface of one; unlike them, it is more frequently found as an interior growth. In the general plans, places, and methods of growth, the myeloid are very like the fibrous tumours, affecting generally the same shapes, and similarly displacing, but rarely otherwise damaging, the surrounding parts. When not encased in bone, they usually feel firm, compressible, slowly resilient, and 'fleshy;' very few are harder than these words imply; but some are much softer, easily broken, like ordinary granulations. On section, their most frequent appearance is that of an uniform grayish or yellowish shining substance, blotched or suffused with deep crimson, or pink, or blood-colour. The range of varieties of appearance is very wide; and besides, partial ossification, with plates or bars of bone intersecting the tumour, is not rare; and cysts filled with serous or bloody fluids are, in the instances of large myeloid tumours, frequent. Indeed, it is probable that not a few cysts in the articular ends of bones are examples of myeloid tumours, in which cystic formation has led to the almost complete exclusion of the solid structure. They usually appear lowly vascular, even when they are very ruddy (for this tint does not depend directly upon blood in them), or when, as sometimes happens, they pulsate.

The most distinctive microscopic structures of myeloid tumours are many-nucleated bodies,—cells, or masses or disks resembling cells. Of these, the greater part are oval or roundish, but many are of irregular shapes, and all have very faint outlines; their nuclei, from two to ten or more in number, are oval, small, well defined, nucleolated. With these corpuscles others are mingled in various proportions, and of somewhat various forms, in different specimens. They are chiefly free nuclei, like those in the many-nucleated bodies; small corpuscles like the white blood-cells; and lanceolate or variously elongated, and caudate cells (fibro-cells, or fibro-plastic). These various elements, mingled without apparent order, or imbedded in granular or molecular matter, make up, together with blood-vessels and filamentous tissue, the solid part of a myeloid tumour. Similar elements are sometimes mingled with those of cartilaginous tumours, and even with those of cancers, of bone.

Myeloid tumours are seldom referable to any evident cause, such as injury, inheritance, or defective health. They very rarely begin to grow in early life, or in old age; most frequently between youth and middle age. Their growth is usually slow and painless. The structures investing them usually remain healthy, even when greatly distended, and when the mass within is degenerate or cystic.

In the diagnosis of myeloid tumours, the diseases most likely to be confounded are cysts, fibrous or cartilaginous tumours, and cancer, of bones. When the growth is external (and it is so very rarely except on the jaws), a fibrous growth is alone like it; and the distinction, if any be possible, may be in that the myeloid is softer, more elastic, and more vascular than the fibrous. But, indeed, this diagnosis is of little importance. When the growth is within bone, it must be very difficult to make any nearer diagnosis than that between myeloid or some other innocent tumour on the one hand, and cancer on the other. And for this, the chief facts are, in the usually slower growth of the former; its broadly rounded shape, and seat in the articular end rather than the shaft of a bone; the absence of glandular disease, and of all cachexia, even though the growth may have been three or more years in progress. On the other hand, softness to the touch; penetration of the thinned walls of a bone; the existence of cysts containing blood; great bulk; pulsation at any part not covered with bone,—all these, which are more commonly signs of cancerous growths, may be found in myeloid tumours.

What was said of the treatment of fibrous tumours of bone might be repeated for the myeloid; and the prognosis is, usually, as favourable. Nevertheless, cases have occurred, exceptions to the general rule, in which secondary myeloid disease has been found in lymph-glands and in the lungs. It is not known whether these occurred through continuous growth, and direct carriage of materials with the blood, as in the case of the cartilaginous tumour before mentioned (p. 490); or whether it were through such a more general infection of the blood as is supposed in the diffusion of cancer.

Osseous tumours. Under this name, those tumours are alone included which are composed entirely of bone, whether compact or cancellous with marrow. When cartilaginous or myeloid tumours are in process of ossification, they are usually grouped with those of the same name in which no such process is observable; when the ossification is complete (which, however, happens only with the cartilaginous), the tumour changes its name to osseous. Moreover, many growths of bone have some affinity with osseous tumours, yet do not bear the name; just as there are local overgrowths of fat which are not named fatty tumours. Generally, none are called osseous tumours but such as are either disconnected from bones, or are connected with them by well-defined, and usually small, attachments, which grow, if at all, at a less rate than the outstanding masses.

Of such osseous tumours there are two chief varieties; the cancellous, and the compact or ivory-like. The former consist of a structure like the natural medullary tissue of bones, containing marrow enclosed in cancellated bone, and usually invested with a very thin wall or layer of compact tissue. The latter are composed entirely, or nearly so, of hard solid bone, like that of the shaft of a femur, for example. The cancellous osseous tumours are probably always developed through cartilage; the compact or ivory-like are rarely so formed. Usually, in both we observe a close likeness between the bone and other structures composing them, and those of the bones on which they severally grow. Thus, with rare exceptions, such as grow on long bones have perfect marrow in wide cancellous spaces; those on the skull are very hard, and, if in part cancellous, they contain diploe; and those which are peculiar to the last phalanges of the toes are formed of hard finely cancellous bone, just like the phalanges themselves.

The general account of the cancellous bony tumours can scarcely be more than a supplement to that of the cartilaginous tumours of bones; for in many, if not all, cases, they are but different stages of the same disease. Therefore, for facts concerning the origin, most frequent seats, apparent causes, &c., reference may be made to p. 486, and to the essay on DISEASES OF THE BONES; and it need only be added, that the minute as well as the larger structures of these osseous tumours are identical with those of the bones on which they are seated, and with whose textures theirs are continuous. The grounds for the diagnosis of a cancellous osseous tumour are, also, the same as for a cartilaginous one in a similar position. They may sometimes be distinguished from one another by detecting the unyielding hardness of the one, and the slight compressibility and strong resilience of the other; but this diagnosis is often impossible, and seldom important. So, in regard to treatment, all that need be added to what is said at p. 490, is, that when a tumour is thoroughly ossified, it is not likely to grow fast or much; and that the cancellous osseous tumours are always external to the bones with which they are connected, so that excision, not excavation, must be the method for their removal.

The compact or ivory-like osseous tumours are very rare in connexion with any bones but those of the skull; and here they occur in two forms. Some grow on the exterior of the bones of the vault of the skull, in smooth, spheroidal, or lens-shaped lumps, attached, commonly, by rather narrow bases. Others, which are usually of deeply-lobed and nodular shapes, grow in the diploe, or the frontal or other sinuses, whence, as they enlarge, they project through the gradually thinned and perforated layers of bones that at first enclosed them. The former kind rarely increase to an inch in diameter; the latter may increase to many inches, and they commonly project into the cavity of the skull, as well as externally or into the cavities of the orbits or any other adjacent parts.

The substance of both these forms of hard osseous tumour is true bone, compact, normally vascular, and generally having some small portions cancellous, or like diploe.

The diagnosis of these extremely hard bony growths from any other tumours is rarely difficult. They could not, indeed, be distinguished from masses of cancellous bone covered with a compact layer; but these rarely, if ever, occur on the skull. And of other tumours likely to occur there, there are none that can equal them in hardness as well as apparent fixity, unless it be certain small cutaneous cysts, shrivelled and with calcified contents. A much greater difficulty of diagnosis is sometimes between the hard osseous tumours and certain circumscribed hard hypertrophies of the bones of the skull or face. The main differences lie in the circumscription of the tumour compared with the diffuseness of the hypertrophy; the narrower base of the former, the wider of the latter; the greater height or projection of the tumour, its comparative smallness when on the vault of the skull, its painless and slow increase. Besides, the hypertrophies are not rarely symmetrical, and their general seat is in or near the superior maxillary bones; the tumours grow singly, and either on the vault of the skull or at the orbit.

In the treatment of these hard osseous tumours, excision is the only fit remedy for those on the vault of the skull. But it should not be undertaken unless it is certain that the tumour is increasing, or for some equally good reason; for the extreme hardness of the bone makes the operation difficult, and not a little dangerous. The tumours at the orbit, as a general rule, are not to be removed by excision or any similar operation; their hardness, deep connexions, and frequent projection towards the brain, render such proceedings extremely hazardous. Occasional cures of such tumours by necrosis and spontaneous separation may justify, in some instances, the practice of exposing their most prominent part, and destroying it with some caustic, in the hope of killing the whole mass, so that it may exfoliate.

There is no probability of renewal of growth after the removal of an osseous tumour; and even when the base of attachment is left, it is not likely to grow up again. It is to be noted, however, that certain cancerous tumours of bones enclose a kind of osseous skeleton, and that a great part of an osteoid cancer may be heavy and compact bone. When these, like other cancers, recur, the secondary tumours, wherever seated, may contain bone; but the distinction between the cancerous and the simple osseous tumour is seldom difficult.

In a great majority of cases osseous tumours occur singly; but rare instances are occasionally seen, in which patients have a large number on many bones. These are usually symmetrical and hereditary; and their growth, if not intrauterine, begins in earliest infancy. Indeed, they partake of the characters of monstrosities by excess, as much as of those of tumours.

Glandular tumours. It is probable that growths of the nature of tumours may be formed in imitation of the structures of glands of all classes, whether lymphatic, vascular, or secretory. But of those that resemble lymphatic glands, it may be impossible to say that they are not merely enlargements of glands naturally existing, though, sometimes, their number may surpass that of the glands of smallest size that could be found in healthy subjects. Omitting these, therefore, as doubtful, two classes of glandular tumours may be noted, of which the one includes those like vascular glands, and has for the chief example the thyroid, while the other comprises those whose structures are like the essential structures of secreting glands. Of these, the most frequent examples are the mammary glandular, or chronic mammary, tumours.

The thyroid glandular tumours are very rare, unless those be included (as they rightly might be) which appear as distinct and completely incapsuled masses imbedded in the substance of enlarged thyroid glands or bronchoceles. These have their best parallel in the prostatic tumours enclosed in enlarged prostates; but their pathology is involved in that of bronchoceles, and they are not commonly counted as tumours. The name, however, cannot be refused to the similar masses which lie near the thyroid gland, but not in it, and which grow irrespective of its growth. They are too rare to justify many general statements concerning them. Their growth is, probably, most frequent in or near middle age; slow, painless, sometimes attaining a very large size. They resemble thyroid gland in both visible and microscopic characters; and, if any diagnosis could be made of one of them during life, it would be by the likeness of its 'feel' and its proximity to the natural organ. But diagnosis would, probably, not come nearer than to the expectation of some innocent tumour, for which excision would usually be the proper and sufficient remedy.

Of the tumours resembling secreting glands the best-marked are the mammary, prostatic, labial, and parotid, named, severally, after the glands whose structure they imitate, and in or near which they are found. Leaving many facts concerning each of them to be related in the pathology of the several glands, it must suffice to mention here those characters which are common to them all. They all affect regular round or oval shapes, or are lobed as if compounded, or they may be flattened in adaptation to pressure. They are generally invested with distinct capsules of connective tissue, from which it is not difficult to enucleate them, and through which they derive a sparing supply of blood-vessels. On section, they commonly appear lobed, or intersected with partitions of connective tissue, and are pale, grayish- or yellowish-white; in some specimens looking translucent and glistening, in others opaque; in nearly all acinous or glandular. To the touch some, especially the whiter and more opaque, are firm, tenacious, and elastic; others, especially the yellow and more glistening, are softish, brittle, slippery, and succulent, with fluid like serum or synovia. Not rarely, cysts are imbedded in the solid growth, and filled with serous or other fluids like those which are found in the barren cysts of the mammary gland itself. In the labial and parotid glandular tumours, portions of cartilage or bone may be mixed with the glandular structure. And, sometimes, chiefly in the mammary, the glandular tumours appear as if formed wholly or in part of clusters of small sessile or pendulous growths filling cysts or partitioned spaces; thus indicating their relation to the proliferous cysts described at p. 470, and suggesting that they originated in such cysts. The textures around the tumours are usually quite healthy, altered only by displacement.

The microscopic structure of glandular tumours imitates, in its essential features, that of the glands in or near which they are severally found; but is often rudimental, or imperfect, or degenerate. Perfect gland-ducts, indeed, do not appear in even well-marked specimens; but cells, like those of the normal secreting structure, are arranged in tubules, or are clustered as in acini, enclosed within simple membrane, and often bounded by connective tissue, so that many glandular tumours present, in their fragments, close resemblances to the terminal lobules of the normal glands. In the firmer or harder specimens, an excess of connective tissue is commonly found; in the prostatic, as in the natural prostate, smooth-fibred muscular tissue is mingled with the glandular.

It is not possible to state any general truths respecting the date or manner of origin, the rate of growth, or other particulars of the life of glandular tumours; for in these, the several kinds present varieties, which appear to have some relation to the functional conditions of the glands they severally resemble. For a general rule of diagnosis it is true that any tumour, in or near a gland, which presents the characters above described, and is regular, very circumscribed, smooth, mobile, surrounded by healthy structures, painless, and of slow growth, is very likely to be glandular; but the diversities in degrees of firmness, in pain, in rate of growth, make the diagnosis often very difficult. The mammary glandular tumours present many striking instances of this.

The glandular tumours, if we may regard the mammary as an example of the whole class, not only cease to grow more often than others do, but may be removed by absorption. This happens not rarely with small mammary glandular tumours, and their arrest of growth is frequent. Either event is most likely to occur when the natural function of the normal gland, after being suspended or retarded, comes to be duly exercised. When removal by operation is requisite, enucleation from within the capsule is the proper means, and is, with few exceptions, a final remedy. The exceptions are met with in cases in which very soft mammary glandular tumours are repeatedly recurrent. These will be referred to hereafter.

It was mentioned at p. 479 that many of the softer kinds of polypi are composed, in great part, of glandular tissue. Many of them, indeed, including most of the so-called mucous polypi of the rectum, uterus, nose, and antrum, might properly be called glandular outgrowths; for they consist, mainly, of glandular structures similar to those of the mucous membrane from which they proceed, but arranged disorderly, and often dilated, saccular, or overgrown.

Vascular or erectile tumours are such as have, for their chief and characteristic structure, minute blood-vessels, tortuous, saccular, or dilated, variously communicating, and, as it were, matted together in a mass which is imbedded in the subcutaneous or some other tissue. Their most common seat is in or beneath the skin, where they are the so-called vascular nævi; but they may be found, though rarely, in muscles or intermuscular spaces, in the liver, in bones, or (it may be) in any other vascular structure. Those instances of the disease are alone reckoned among tumours which appear as masses or 'lumps' of whatever size; those that are wide-spread, diffuse, and superficial, such as the common cutaneous nævi (port-wine spots, spider-marks, and the like), are reckoned as separate examples of telangeiectasis.

The vascular tumours are commonly divided into three kinds, named capillary, arterial, and venous. In the first, nearly the whole structure consists of the large, dilated, and convoluted capillaries, with which arteries and veins of not more than proportionate size are connected. In the second, the basis and chief mass of the structure is the same; but there is a very great excess of large tortuous arteries, proceeding to the mass, and even passing through it. In the third, not arteries, but veins or venous spaces, predominate, and a great part of the mass has a cavernous, spongy structure, just like the erectile tissue of a penis.

The most frequent seats of the capillary vascular tumours are in the subcutaneous tissue of the scalp, face, and trunk. Some of them, seated entirely beneath the cutis, are covered with healthy skin; but in many more instances the cutis over the middle of the mass has the same disease of its vessels, and is crimson, very thin, and often granulated. The usual shape of such tumours is round or oval, more or less flattened (especially on the scalp); they are well circumscribed by connective tissue, which would probably form a perfect capsule but for the number of blood-vessels that pass through it to and from the contained vascular mass. The principal arteries usually enter the mass immediately beneath the skin; the veins leave it at all parts. On section after death or excision, the shrunken tumour, which during life was turgid with blood, has usually a brownish colour, and is lobed, soft, and tough. Its lobes are separated by connective tissue and, it may be, fat, belonging to the natural structure between the skin and superficial fascia.

The minute vessels of such a growth may be best seen in microscopic sections made after boiling in acetic acid. They present the most varied and complex convolutions and anastomoses; many of them are irregularly sacculated and varicose; and many that are much larger than ordinary capillaries have only the same simple structure as the smallest. The arteries leading to these capillaries are commonly more tortuous than those of healthy skin, but are not otherwise peculiar. The veins are ordinary, or only larger than for healthy skin.

The venous vascular tumours are not rare in the same seats as the capillary: but they are more often deeply seated; for instance (to speak only of such as may need surgical treatment), in or between muscles, in the orbit, or the tongue. In most of their characters they are like the capillary kind; but, on section, they look like fine network or sponge-work of shining bands and cords, and are often dark venous-coloured in their meshes. Their collapse, after removal or section, is even more complete than that of the capillary tumours; so much so, indeed, that if in operations they chance to be cut into, they close in, empty themselves with a gush of venous blood, and almost disappear. Large veins pass from them, often tortuous and clustered, or like sinuses.

In the arterial kind of vascular tumour (the so-called aneurism by anastomosis), the peculiarity superadded to the general characters already described is, that numerous large arteries enter the mass at many points of its circumference, and before or directly after their entrance give off numerous branches which are variously tortuous and convoluted. Parts of the tumour, indeed, which may feel softly solid, may consist entirely of the convolutions of one artery.

To this general account of the structure of the vascular tumours, it must be added, that specimens are not rare which appear very different through degeneracy or other changes of the original structures. Serous and sanguineous cysts are rather frequent complications (see pp. 465, 8). Parts of the vascular structure may be consolidated either with blood-clots, or with phlebolithes, or with closure of the vessels and a kind of scarring process. A good example of this is often seen at the centre of the cutaneous part of a capillary vascular tumour, which appears as a white, smooth, and scar-like patch, surrounded by a vascular ring. Similar scar-like portions are sometimes seen in the very substance of a tumour; and, occasionally, one finds nearly the whole mass of a tumour, which one may know by its history and some remaining characters to have been vascular, changed into a soft but tough and dry yellow-ochre or brown substance, like that of a supra-renal capsule. Moreover, though by far the greater part of these vascular tumours have their seat in circumscribed portions of normal structures, yet the enormous growth of blood-vessels in which they essentially consist may take place in those of a tumour, and convert part, or the whole of it, into a pulsating or erectile mass. It is probable also that one form of vascular tumour may be converted into another: a capillary one becoming either arterial or venous by the excessive growth of one or other set of vessels; or an arterial one, by opposite changes, becoming either capillary or venous. By disease or injury, or during fever, they may perish or be acutely inflamed. A good result of such an accident is, that they may be consolidated; an evil one, that ulceration may ensue, exposing parts of their substance, and forming irritable and often bleeding sores, that rarely heal soundly.

The greater part of vascular tumours involving the skin appear at birth or in early infancy; and probably those that are deep-seated have an equally early origin, though they are longer overlooked. But such tumours may first appear in later life, though, as years advance from childhood, they seem to originate more and more rarely. Their rate of growth is very uncertain, and often, as it were, capricious; sometimes proceeding very rapidly, sometimes even in the same tumour scarcely notable. Very commonly their increase is only proportionate to that of the rest of the body; and when full growth is attained, they also cease to grow. Not rarely they are stationary, or shrink, even while the rest of the body is growing; and this is especially likely to happen with those that are white and scar-like where the skin is involved. These happy occurrences, however, cannot, in any case, be so relied on as to found a safe rule for practice; growth may ensue, or troublesome changes, in a tumour that has been even for many years stationary and quiet.

The diagnosis of a vascular tumour can scarcely be doubtful when the skin is involved; but in those that are deeper there may be great difficulty. The arterial, having pulsation, may generally be known by it; but for the capillary and venous, the chief signs to be looked to are, their circumscribed shape, softness, 'puffy' feeling, compressibility almost to emptiness, slow swelling up when the pressure is removed, increasing size and tension during strong expirations or when their venous trunks are compressed, and, sometimes, their bluish tint seen through the skin. If with these characters the tumour is known to have been congenital, and to have frequent variations of size, its diagnosis is nearly certain.

There are few, if any, tumours for which so various treatments are applicable as for these. Excision, ligature, cauterisation, consolidation by several methods, pressure, and many more are advocated, and appropriate cases may perhaps be found for all.

Excision is often supposed to be dangerous on account of hæmorrhage; and it might be so in the case of a very large arterial vascular tumour. But there is no such danger in the capillary and venous forms; and if they be not cut into, and the knife be kept close to the investing capsule, they may be excised as safely, and almost as easily, as any other tumours of the same dimensions. The advantages of the plan are, that it is simple, painless (with chloroform), and complete, so as to need no repetition; the objections to it are, that if much skin have to be removed, it leaves unsightly scars, and that the possible consequences of cutting operations should often be avoided if the same end can be attained by safer means.

Some of these objections are avoided by the écraseur, and in certain of these tumours it may be very appropriately used.

Ligature has the advantage of safety from hæmorrhage, and is therefore very appropriate to the arterial tumours, especially to such as are not too large to be treated all at once. Its disadvantages are, that it requires either the removal or the dissection of as much skin as excision does; and that it is painful, and is followed by tedious sloughing and suppuration, with all the liabilities of open wounds.

Cauterisation is a good means for many of the arterial tumours, especially when they are ulcerated. The actual cautery, or, of the potential, those that make the driest sloughs, such as the chloride of zinc, or the Vienna paste with much lime, should be used. These caustics may, also, be safely employed for the capillary and venous tumours; but for those that are small and not deep, the nitric acid, or acid nitrate of mercury, is more convenient; and for those that are large and deep-set, it is better (if caustics are to be used at all) to penetrate their very substance with probes armed with nitrate of silver or chloride of zinc; or to surround them, according to the manner lately recommended by M. Maisonneuve, with sticks or 'arrows' of caustic, and so to extirpate them.*

There are, however, few cases of the larger capillary or venous nævi, in which consolidation is not better than any use of caustics. It may be effected by injection of solutions of ammonia, or other stimulating fluid, into the substance or meshes of the tumour; but, for nearly all the cases to which this method is applicable, the best material is the saturated solution of perchloride of iron introduced into the tumour, in drops, passed through numerous punctures, with the perforated needle and screw-syringe. Setons may be combined with this method of injection, or may be used alone when the tumour is small enough for the inflammation caused by them to consolidate it in a moderate time; and their utility is increased if each thread be soaked in the solution of the perchloride. The insertion of needles into many parts of the tumour may produce the same effect as setons; but there can scarcely be any cases in which this method is to be preferred to others already mentioned; and the same may be said of many other plans, such as vaccination, the rubbing-in of tartar-emetic, croton-oil, and the like, which are indeed appropriate to the entirely cutaneous vascular nævi, but are insufficient or too tedious for the cure of the substantial tumours.

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* The methods of employing caustics, ligatures, &c. for these and other purposes, will be described in the essay on MINOR SURGERY.

Pressure, either with pads and elastic bands, or with firm bandages, or with the slack air-pad and truss-spring of Dr. Arnott, has been successfully used in some cases, even of the arterial tumours. It is most, or, indeed, almost only, applicable when the tumour lies over bone, or some other very firm base, on which pressure can be continuously made.

When a vascular tumour has been thoroughly removed or consolidated by any of the means above described, there is little or no probability of recurrence. If small portions have been left, they may increase, but, probably, as frequently they shrivel and slowly disappear; and generally, it may be remarked, that long after any of the methods of consolidation have been discontinued, curative changes go on; so that a vascular tumour which may have appeared imperfectly cured, may, in a few months, be completely obliterated and out of sight.

As an appendix to the foregoing account of tumours, it may be well to refer to some, or to certain diseases resembling tumours, that present prominent characters so peculiar as to have suggested names by which they are, with some practical advantage, often spoken of.

Recurrent tumours. In the preceding pages it is stated of each kind of tumour that, after the complete removal of one, no similar growth is likely to occur on the same or any other part. This is the general rule for the whole class of innocent tumours, and a character by which they are proved to be essentially different from cancers, among which it is as general a rule that after the removal of one, others are likely to appear in the same or other parts. There are, however, examples of tumours which, in respect of structure, resemble those that are usually innocent, and yet constantly recur or renew their growth after even repeated, and apparently complete, removals. The character is so important, whether in a pathological or in a merely practical view, as to justify the grouping of these tumours, under a distinctive name, apart from those with which, according to their structure, they should be arranged.

The greater part of the recurrent tumours hitherto observed have, in structure, most nearly resembled the fibro-cellular or fibrous; and hence the name of 'recurring fibroid' by which the writer first described them. But some have been cartilaginous; some glandular; some in the form of proliferous glandular cysts; and it is probable that the character of recurrence may be found in certain rare instances of tumours of any other structure. This, however, belongs to all yet observed, namely, that their structures are imperfectly developed; resembling the embryonic, or rudimental, rather than the perfect, states of the several natural tissues. Thus, the recurrent fibroid are composed, chiefly or entirely, of elongated, caudate, oat-shaped or awn-shaped nucleated cells, resembling the so-called 'fibro-plastic' cells, which are a chief constituent of granulations, and other examples of developing connective tissue. And this rule of persistent or arrested embryonic structure in the recurrent tumours is so general that, in practice, it is prudent to speak very doubtfully about the future of any case in which a tumour that has been removed presents embryonic structures.

The most frequent seats of recurrent tumours are the same as those of the innocent tumours which they most nearly resemble in their structure: the connective tissue of the limbs for the fibroid; the bones, especially the long ones, for the cartilaginous; the breasts for the glandular. They usually begin to grow between youth and middle age; very rarely in either childhood or advanced life. Their increase is, generally, speedy, sometimes very rapid; in one case, a pound per month. In their increase, they stretch and displace the surrounding structures; and though they do not infiltrate them, yet they often adhere very closely, and have little, if any, investing capsule; and when they are subcutaneous, the skin is apt soon to inflame and ulcerate, and allow them to protrude.

The general appearance of recurrent tumours is, in their first growth, often not distinguishable from that of tumours of the same structure that are not likely to recur; they may look like ordinary fibro-cellular, fibrous, or other tumours. More often, however, they differ from these ordinary tumours in that they are softer, more succulent or glutinous, glistening or translucent, brittle or easily torn, with a kind of fibrous grain. Commonly, all these peculiarities become more marked in the successive recurrences of the tumour; and the later growths are, generally, like masses of yellow or ruddy soft gelatine, with blood-vessels. The later are, also, usually much more rapid in their progress than the earlier growths, and are, generally, less well defined, penetrating further and more vaguely among the interstices of adjacent parts, and more quickly protruding through the skin or scars over them.

The likeness of recurrent tumours to cancers in many of these points is evident. But their unlikeness is as distinct. They rarely look like cancers to the naked eye, never to that assisted with the microscope: their homology with the natural structures, though in a rudimental and it may be degenerate state, is clear. They do not affect the lymphatics; their recurrence is *in loco;* and in the few cases in which, late in the disease, similar growths have occurred in the lungs, it may be suspected that the propagation was by direct carrying of germs with the blood from vessels into which a tumour had grown; as in the case of cartilaginous growth in the testicle, mentioned at p. 490. Moreover, after repeated recurrences, the patient commonly retains apparently good health, and shows none of that cachexia which would almost certainly exist in a patient who had suffered repeated recurrences of cancer.

The combination of characters like and unlike those of cancers suggests that the recurrent tumours may be diseases intermediate or transitional between the innocent and malignant. And the suggestion is strengthened by the comparative frequency of their occurrence in the descendants or near relatives of those who are or have been cancerous. It is as if their growth were due to some diathesis through which the cancerous, in some instances, fades away into health, or is, in some, gradually developed.

The diagnosis of a recurrent tumour may be, in the first instance, impossible. It may be suspected when a tumour, which lacks the other characters of a cancer, grows with unusual rapidity, soon protrudes, and is soft, easily broken, and readily bleeds. But only the fact of recurrence can establish the diagnosis, even when the first tumour after removal has been examined.

The rules for the treatment of recurrent tumours are the same as for those which their structures most nearly resemble; but in their excision it is often necessary to cut wide of them, because of the difficulty of enucleating them, and the liability to leave fragments of them. No limit of number can be stated beyond which it would be wrong to remove these tumours as often as they recur; for there will always be some probability that recurrence will not again ensue. The writer has known cases in which recurrence ceased, for at least seven years, after a fourth and a sixth operation; and after every operation the patient may expect to enjoy a period of comfort. Dr. Esmarch of Kiel—an authority not likely to err—told the writer that he has seen cases of recurrent fibroid tumour cured, and not again returning, in patients who took large doses of iodide of potassium for several weeks. Generally, the prognosis of recurrent tumours must be unfavourable, unless Dr. Esmarch's plan prove often curative. The ordinary course is, that the tumours constantly recurring grow more rapidly; leave shorter intervals of health; protrude sooner; bleed and discharge ichor more freely; and affect deeper and deeper structures, till excision becomes too dangerous, and the patient dies exhausted. In some cases, however, as already stated, recurrence, after many times, ceases, and the patient may then regain perfect health.

Irritable or neuralgic tumours present, with whatever other characters, an altogether disproportionate intensity of pain; pain such as can be compared only with that of severe neuralgia, like which, too, it is at present quite inexplicable. The tumours with this peculiarity are most frequently subcutaneous and fibrous, or fibro-cellular; and to these the name of painful subcutaneous tubercle is often given. But the pain depends on neither their locality nor their structure: for, in the same situation, the writer has found fibro-cartilaginous and fatty tumours similarly painful; and the same kind of pain is observed in the irritable mammary glandular tumours. Neither is the painfulness of these tumours evidently due to any peculiar connexion with nerve-fibres; for many of them have no manifest connexion with nerves; and tumours in nerves, or involving them, are very rarely painful in the same manner or degree as these.

The most frequent seats of tumours thus painful are the limbs and breasts. They are much more common in women than in men; and are very rare in both early life and old age. Their increase is usually very slow; and it is remarkable that they seldom, if ever, grow much beyond half an inch in diameter. They are not prone to inflame, or ulcerate, or undergo any degeneration.

The diagnosis of these tumours is established by their pain. It is not usually constant, or is not always nearly equal in severity; but is, rather, paroxysmal, and is provoked to its greatest intensity by injury. It is often described as darting or flashing from the tumour to adjacent parts; often, it increases continually for an hour or more, and then slowly subsides; and, while it continues, the tumour is generally excessively sensitive to the touch, and often swells. In some patients the pain is attended with spasms of adjacent muscles, or even with general epileptiform convulsions, or with syncope.

Excision is the proper remedy for neuralgic tumours. Their pain can rarely be mitigated by any local means, unless, in some cases, by circular pressure round them, as with a ring laid on the surrounding skin and deeply impressed. After excision, the pain is not likely to return in the scar; and if the excision be complete, no recurrence of the growth is to be expected. Cancerous growths, indeed, even in the skin, appear not liable to be thus neuralgic.

Pulsating tumours. The chief interest of these lies in the necessity of distinguishing them from aneurisms and from one another. Any tumour may appear to pulsate when it lies within the range of the pulsations of an adjacent artery; but, in this case, it will not pulsate equally in all directions, or as if with equal expansion, but chiefly where the artery is nearest; its pulsations, also, will cease, or be diminished, by moving it from the artery; its bulk will not quickly vary, according as the blood-stream through the adjacent artery is allowed or checked by pressure. Pulsation not thus communicated, but due to the condition of the tumour's own blood-vessels, may be found in medullary cancers, in arterial vascular tumours, and in some instances of myeloid tumours. Probably it may occur in any in which the arteries are developed much beyond their due proportion to the veins; but the tumours above named are the only kinds which appear liable to this condition. Of whatever kind, tumours in or involving bones are much more often pulsatile than those in any other situation.

The diagnosis between pulsating tumours and aneurisms is dealt with in the essay on DISEASES OF ARTERIES. That between the several kinds of pulsating tumours must depend on the other characters which they severally present, and which are enumerated in this essay and in that on CANCER.

Floating tumours. Thus certain 'lumps' are named, which are not rarely felt in the abdomen. They are most frequent on its right side, and in women; and most frequently they feel about as large, and of nearly the same shape, as a kidney. They are usually smooth, moderately firm and elastic, and are singularly movable in the abdomen, so that they can be pressed upwards under the ribs, or downwards nearly to the pelvis, or, again, to the loin, or across the middle line; and as one examines them, they seem to slip away under the fingers, and have to be again searched for. The patient is conscious of the movements of the tumour, and sometimes describes them as a 'swagging,' and feels much discomfort from them, and generally ascribes to the lump some dyspeptic troubles.

It is usually impossible to say what a 'floating tumour' is. Some suppose them to be all movable kidneys, *i. e.* kidneys attached by loose tissue to the loin, so that they can be freely moved. But if they were so, such kidneys ought to be not unfrequently seen in autopsies; for floating tumours are not rare. The writer has examined nine or ten, but never yet saw a loose kidney. Doubtless, in some cases, the apparent tumour has been a kidney; in some it has been a loosely attached ovarian cyst or tumour; sometimes fæces, impacted in the colon, have long felt like such a tumour; but in many instances the case remains to the last unexplained, a constant annoyance to the patient, though probably without any direct influence on the health.

Phantom tumours. Partial contractions of muscles may produce, by the swelling and firmness of the fibres, an imitation of a tumour; and when the contraction subsides, the tumour disappears, phantom-like. The abdominal muscles of hysterical women are most often thus affected; sometimes with intentional fraud. The imitation of a tumour may be so close as to require great tact for its detection, or else chloroform, which, by relaxing the muscles, dissipates the swelling. Occasionally, these apparent tumours move. A child was lately brought to the writer with what was described as a 'shifting tumour' in the neck. Some of the fibres of the right trapezius muscle, contracting, rose-up tumour-like; and as they relaxed, and similar contractions affected, successively, other bundles more and more distant from them, the 'tumour' seemed to move from one part of the muscle to another.

JAMES PAGET.

CANCER.

IN the following attempt to furnish a brief general account of the subject of Cancer, I have made but little endeavour to assign to preceding authors their respective discoveries. However gratifying such a course would have been, it would now be most difficult to adopt it, since it would involve the distinguishing between information obtained by personal observation, and that which may have been suggested to observation by the former perusal of already published writings on the disease. Such works as those of Rokitansky and Lebert, of Paget, Walshe, and Simon, as a matter of course, and the statistical details drawn by Mr. Sibley from the Cancer Records of the Middlesex Hospital, and published by him in the forty-second volume of the *Medico-Chirurgical Transactions*, have supplied, with my own notes, the principal materials of the following article.

The subject of Cancer is one in which there is the strangest disproportion between the amount and the practical value of our knowledge. The principal achievements of modern investigation have extended little further than to the more exact definition of the disease, its structure, varieties, and history. Maladies formerly confounded with it are now capable of being discriminated; but true cancer retains not the less its claim to the epithet 'incurable.'

The diseases designated by the title are spontaneous growths of a nature different from the healthy structures in which they originate, and exhibiting a mode and power of life unlike, and but partly dependent on, the life of those structures. They are not so much foreign to the body as they are to the existing stage of its development. They possess most of the conditions which seem essential to life in the human body, having a system of blood-vessels, being closely connected with the absorbent system, and, since they are sensitive, being potentially, if not visibly, endowed with nerves. Cancer is thus, and for the most part correctly, brought into a general classification with TUMOURS. It is, however, generally, and in many respects widely, distinguished from them.

The most usual characteristic assigned to cancers, to separate them from the diseases which have been described in another article as tumours, is contained in the epithet 'malignant.' If this express a quality, superadded to those of other growths, of producing or arising from a fatal constitutional taint, that epithet may be retained. But when applied to certain characters of cancer which are essentially local, as to its proneness to early ulceration and sloughing, to its frequent reproduction after excision, or even to its power of multiplication in many parts, it is not exclusively applicable to cancer, since some innocent growths share those characters to a considerable extent. The term, in fact, is one which has arisen out of the exigencies of surgical practice, which is incidental rather to the question of a surgical operation than to the characters which distinguish tumours as cancerous; and it should be retained only as expressive of their constitutional nature. The further distinctions which are now to be drawn between the innocent tumours and cancer, are to be considered as generally true. No single quality is exclusively characteristic of all the latter diseases, nor are all the qualities detailed to be found in every case of even unquestionable cancer.

Cancer is unlike all other tumours, in being an infiltration amongst the natural tissues. This is equally plain to the naked eye, and in respect of structures only discernible by the microscope.

The constituent structure of cancer bears for the most part no resemblance to the particular tissue which it infiltrates. It springs, therefore, and subsists indifferently in any organ of the body, being little modified by the latter in its own texture. Any number of malignant tumours may consequently coexist in the most various structures, yet possess in all nearly common characters. This multiplication of cancers is almost sufficient to distinguish them. Most multiple innocent growths, however numerous they may be, are limited to organs with which their texture is somewhat allied; but cancer, commencing in one structure as a single tumour, is commonly, though not invariably, found after a time in many similar tumours, which occupy dissimilar tissues and distant regions of the body, equally with the immediate vicinity in which the first appeared.

Cancer exhibits a destructive hostility to the previous or the adjoining natural structures. It is usual with innocent tumours to respect those structures, merely displacing or compressing them; sometimes even leading to their hypertrophy. Before the cancers, however, the indigenous parts disappear, being supplanted by, perhaps appropriated to the nourishment of, the new tumour. It is probable, nevertheless, that some portions of the old organ not unfrequently escape the common destruction, and are worked into the structure of the cancer.

Although the cancers often manifest a great power of growing, yet their materials are never elaborated into an enduring structure. The growing of most innocent tumours issues in a single final textural element, but that of cancer in many. And as of these many the most are mere cells, a cancerous tumour possesses little vital stability, and is prone to early degeneration, destructive inflammation, sloughing, and ulceration. In spite, however, of this decay, cancer continues to be reproduced in the adjoining parts.

The microscopic structure of tumours offers the most generally true and widely applicable means of distinguishing their innocent or malignant character. There is, indeed, no single element of a cancer which may not also be found in some tumour called innocent. Fibre, cell, nucleus, nucleolus, molecule, liquid—all exist elsewhere, as well as in cancer. But neither in tumours of innocent character, nor in natural tissue, do these various elements combine in such variety as is common in a single cancer.

Cancer is ineradicable. It may be cut out, or spontaneously removed; but it returns. And if it do not return in the part, it nevertheless resumes its growth, as if it had not been cut out, in other and distant organs of the body. Yet, whilst this is given as a characteristic of cancer, in contrast with the habits of innocent tumours, neither the statement nor its converse is of universal application. There are innocent growths which never are finally extirpated, by repeated operations: there are cancers, known to be such by competent operators, which have never reappeared. The statement contains a distinctive truth, but the exceptions may not be ignored.

With rare exceptions, such as have just been mentioned, cancer is in its nature fatal. Sooner or later, if life be not cut short by other intercurrent disease or by some accidental consequence of the local tumour, the inevitable issue of cancer is death. The resources of the body are wasted in supplying a growth which exhausts, instead of contributing, as do normal structures, to the general maintenance and welfare.

Varieties of cancer. The very various forms in which cancer presents itself to the notice of the surgeon admit of the following arrangement:

a. Scirrhous.
b. Medullary.
c. Melanotic.
d. Epithelial.
e. Osteoid.

It is not uncommon to regard the diseases termed Colloid and Villous as varieties of cancers, but their appearance in surgical cases is rarely such as to favour that classification. Their distinctive characters will be made apparent after a previous description of the true cancers. Other forms of the disease are also noted by pathologists, as cysto-carcinoma, dendritic, and reticulate cancer, and fungus hæmatodes; but as their clinical history is little distinctive, I do not separate the account of them from those above enumerated. Rokitansky regards the product of typhus in the mucous membrane and glands of the intestines, and in various glands, to be of the nature of medullary cancer.

a. Scirrhus. Scirrhus is the most frequent form of cancer in this country. The chief site of its primary growth is the female breast; but it is also met with in the tonsils and large intestine, especially the rectum (see DISEASES OF THE INTESTINES and OF THE RECTUM), in the eye, testis, and uterus, the skin, bones, and parotid gland. Secondary scirrhus, though it may occur in almost any structure, frequents especially the lymphatic glands, liver, and bones: in the eye and testis it is unknown. With the exception of the osteoid, scirrhus is the densest example of cancerous structure. In certain organs, and when of rather large size, it is quite distinguishable by its stony hardness; but this character is far from being universal or pathognomonic, even in the breast, which is the most common situation of the disease.

1. The material of scirrhus most commonly concentrates in a mass, and in early stages of the disease often possesses every character of a tumour but that of swelling. For, as it grows, it exhibits the singular property of drawing into it adjoining structures, and including, or, as it were, compressing them with its own substance in a less space than that which, without any cancerous infiltration, they previously occupied. It is, therefore, only a considerable growth of the disease, or emaciation of the organ it occupies, which occasions an appearance of enlargement. The firm hold which scirrhus thus takes on all adjoining movable structures gives it a character which is not possessed in an equal degree by any other tumours. These move amongst the tissues; that moves only with them. In certain situations it can indeed be moved, but a careful observation shows that it does so only because of the looseness of the surrounding tissues, and not because it is unconnected with them. The adhesion of scirrhus to adjoining structures is nowhere better shown than in the rectum, which it tightly constricts, or the breast, where the early shortening-in of certain sub-

cutaneous fibres towards the tumour produces a dimpling or pitting of the skin: the same change in the milk-ducts retracts the nipple, and, in the submammary tissues, restricts the extent to which the breast can be slid over the pectoral muscle. Acute suppurations over a fascia sometimes look like cancer, on account of their producing a similar pitting of the skin, but are distinguishable from it by their uniform firmness, the tension of the intervening convex portions of the integument, and their redness, tenderness, and duration. Until a cancerous tumour has involved the whole of the skin which lies over it, the adhesion is even more marked, because of the looseness and plumpness of neighbouring portions of the skin which are not so fixed by subcutaneous fibres to the tumour. It hardly, perhaps, needs to be stated that scirrhus shows this contractile power only in soft and loose structures; there is no contraction when it is formed in the interior of a bone.

That scirrhus grows by any centric increase of the tumour is not demonstrated, but the growth of its superficial layer is clear from its continuous encroachment upon adjoining structures. Its surface is consequently unequal, and variously nodulated and fissured; some tissues being promptly embodied in the advancing tumour, others long resisting it. Moreover, it does not grow as a whole; one part may be enlarging rapidly, while another is stationary, sloughing, or ulcerating. While one side of a scirrhous tumour, especially its central and superficial parts, is progressively softening and sloughing away, new morbid material may continue to be deposited in the tissues beneath and around it. In this manner a whole organ or a bone is sometimes eaten through, and beneath the gap remains a cancerous basis of the ulcer still. The enlargement of a primary scirrhus is not always traceable to its own growth alone. In apparently healthy adjoining structures, smaller tumours may form, and, as they also grow, may meet and unite with the primary tumour. This mode of incorporation is frequently seen when the subordinate tumours are in the skin, and may be assumed to be a natural process when they are met with in deeper structures. In the vicinity of mammary cancers, for which the whole breast has been removed, I have dissected out many such tumours, scarcely any of which were large enough to have been detected before the operation.

The mere enlargement of a scirrhous tumour is not always a proof of its increase as a cancer; nor, except in rare instances, may its diminution in size be regarded as a cessation of specific cancerous growth. Many patients apply for advice, in whom a scirrhus can be indistinctly felt amongst tumid and tender tissues; but rest in bed for a few days, and suitable applications, produce a decided diminution of both. Neither the increase nor the reduction of the size in such a case is cancerous; they are due respectively to the accession and the removal of mere inflammatory œdema. In like manner, a still more marked and definite swelling of the tumour itself may be occasioned by an attack of suppurative inflammation, and upon its subsidence and the evacuation of the matter the cancer may be found but little larger than before. Nor can the partial swelling which attends the softening of a portion of the tumour be regarded as an increase of the proper cancer. Partly with disintegration of existing cancer-material, partly with the addition of liquid from the blood, or pus, or of extravasated blood itself, a softening of a portion of the tumour takes place. Such softening produces enlargement of a limited extent of the tumour; and if situated superficially, it occasions a thinning, reddening, and at length bursting of the skin covering it. The softened matters then escape, and leave in their place an open excavation or ulcer of the cancer. It is probable that some of the acute suppurations beneath and in the vicinity of a cancerous tumour owe their origin to the escape of such softened débris of cancer-material, since they not unfrequently arise without an adequate assignable cause, and it is certain that softening is not limited to the cutaneous surface of the tumour.

At whatever rate scirrhous cancer may at times grow, its increase is subject to considerable variations. Sometimes it appears to remain unaltered for weeks, and then to renew its vigour and enlarge again.

Bell, in his *Thoughts on Cancer*, 1786, pp. 94-96, describes the cases of two women who came to him with ordinary occult scirrhus of the breast, in whom rapid and extensive cancerous infiltration of a great part of the surface of the trunk took place, and destroyed life in a very painful way. The one died in a fortnight, the other in three weeks after he had seen them. In one, aged forty-six, the disease had lasted a year and a half, was perfectly movable and circumscribed, and unattended with axillary disease. A fortnight afterwards she was in bed, supported, breathing with quick and difficult respirations, with her pulse rapid and feeble, and in great pain. The breast was greatly enlarged, firmly adherent, but not ulcerated. The muscles of the abdomen, neck, and arm on that side were all enlarged, hard, and so contracted that her head and thigh were bent together. The other patient's case was a similar one, and her age thirty-nine. Such an outbreak of cancer-growth, though much less severe, occurred in the practice of my colleague, Mr. Shaw. A lady underwent the operation for extirpating a cancer of the breast, and remained well for three years afterwards. A trifling ulceration of the scar then took place; it was never larger than a shilling-piece, but it continued open for eight years. Exuberant cancer-growth then somewhat suddenly recommenced in the site of the operation and in the neck, and rapidly carried off the patient.

Another patient of Mr. Shaw's was for many years in one of the cancer-wards of the Middlesex Hospital. Her breast had once been removed in another hospital with caustic, but the disease returned, and advanced with a very slow and scanty deposition of cancerous material. In about the twentieth year of the disease the character of the growing altered; large masses of cancer formed with rapidity on the side of the thorax, and she speedily died.

Had the surgeon operated in Bell's cases, the frightful outburst of cancer-growth would have been attributed to his interference; but, in fact, these changes occur upon no manifest condition, and without the employment of medical means which seem to exercise some control over other examples of the disease. The most remarkable occurrence is unhappily that which is the most rarely seen, viz. a complete cessation of the growth, and a slow diminution or withering of the primary cancer. Such cases as the following illustrate this occurrence in scirrhus; it will be noticed again in the section devoted to epithelial cancer.

I was consulted respecting a female patient who had a scirrhous tumour in the right breast, with an enlargement of cancerous nature in the right axillary glands. A small tumour likewise existed beneath the nipple of the left breast, which was less distinctly cancerous, only because it was more movable than that in the substance of the right mamma. In this state I took charge of the patient. Cancerous enlargement and hardening soon appeared in a gland behind the edge of the left pectoral, and that whole muscle was raised by œdematous swelling. Meanwhile every trace of the doubtful cancer of the left breast disappeared. The swelling of the left pectoral region next diminished, and there remained on that side only a very hard gland of the size of a nutmeg. The primary tumour on the right side, which had meanwhile remained without increase, resumed its growth, as the activity of the disease on the left side abated; and after nearly doubling its size, it in turn stopped growing, and partly but decidedly shrank.

I have at the present time under my care a woman, aged forty-six, suffering from cancerous tumours in both breasts, and similar infection of the axillary glands. For many months the primary and secondary tumours in the thoracic region have been lessening, have ceased to be painful, and two of them have become so soft as to appear as if they had been mere inflammatory indurations of breast-tissue. But during the same period she has incessantly complained of pain in the loins, and subsequently in the dorsal region, the cause of which is now manifest as cancerous infiltration of the bodies of the vertebræ, two angular curvatures having formed in the dorsal region, and numbness and loss of motive power of the lower limbs temporarily appeared. A strongly pulsating cancerous tumour has lately protruded from the sternum. In these, and in other cases of withering of cancerous, and especially of primary, tumours, which I have had the opportunity of observing, the diminution was attended either with a growth of cancer elsewhere, or with development of tubercle in the lungs; never with what could be supposed to be a spontaneous cure of cancer. The closest outward observation furnished no clue to the mode in which the growth of the primary cancer was arrested. All were cases of primary cancer of the mamma. No pressure was made upon them. Two subsided under the long-continued application of an opium-plaster; and the recurrence of the disease in one was in the vertebræ, and in the other in the uterus: a third withered without any external application, during an exuberant growth of cancer in the axillary glands; another, during acute tuberculosis of the lungs.

The *size* attained by different primary cancers varies greatly. It is not an accident, determined by the amount of nutrition available in the part, but is a measure of the vigour of growth possessed by the tumour. Hence it happens that a primary scirrhus in the mamma may never in its whole progress exceed the bulk of a walnut, while the same organ in another patient may contain one of five or six inches in diameter. When a primary scirrhus is so small as that first mentioned, its growth has probably been arrested, and the subordinate glands or some secondary tumour increase disproportionately, using up, as it were, the cancer-material. But cases are also described in which the total amount of deposition in the form of tumour throughout the body is small; all the more, however, a general and fatal illness comes on, which is manifested in no derangement of any one organ, but in a permanent quickness of the pulse, loss of appetite and spirits, sallowness, emaciation, a thin watery and pale condition of the blood, and at last in death. These examples of cancerous cachexia, if they are not really cases of abundant and perhaps primary internal cancer, are probably never seen in the scirrhous form of the disease.

The cancerous *ulcer* is often a small and superficial breach of the surface, which remains long hidden beneath a dry scab. When resulting from the discharge of softened parts of a scirrhous tumour, it is at first a deep cavity, with sharp rugged edges and a base of slough or of large prominent cancerous granulations; the discharge from it is thick and muddy, or purulent, or sanious, and is always offensive and peculiar in smell. With cancers of the breast in such a condition, many women present themselves for admission to hospitals; their countenances haggard, unable to sleep on account of pain, feverish, without appetite, and equally depressed and ill in body and in mind. Under suitable treatment for a few weeks, processes of repair will have sprung up in the very centre of the cancer, and changed such an ulcer into a cicatrising and little-painful sore. The health and spirits may be renewed, and the patient even gain flesh. No credit is due to the Surgeon, however, beyond that of having judiciously managed the general health; for temporary improvement of this kind will often occur with various treatment, sometimes even with none but home-comforts and repose. The deposition of fresh cancerous matter continues beneath the growing or the finished scar, and painful sloughings, new softenings, or partial inflammations occurring during the very continuance of the improvement in the general health, and again interrupting it, betray the fact that Surgery has no real control over the advancing disease.

The *cicatrix* of a cancerous ulcer is easily recognised. It is extremely thin, red or violet in tint, and often traversed by large visible vessels. Unlike the scar of a mere wound or simple ulcer, which tardily and rarely rises over exuberant granulations, or dips into hollows, the cicatrix of a cancerous ulcer advances in spite of the inequality of the surface of the sore. Being also incapable of drawing in by its contraction the surrounding firmly adherent skin, it is apt to become extremely tense, and more and more attenuated. It is consequently very liable to ulcerate afresh, and especially so if to its own natural tension be added that arising from a renewed growth of the tumour beneath it. This description does not apply to the scar which closes the space left by the total disappearance of a former ulcerated cancer. The process of cicatrisation is in that case natural, so far as the tissues are free from remaining cancerous material.

In some cases of scirrhus, a prolonged struggle seems to go on between the diseased and the healthy propensities of the part which have just been described. Four times in the same patient, and in the same spot, I have seen the greater part of a scirrhous mass slough out, and cicatrisation and granulation take its place. This occurrence is not uncommonly observed in scirrhus of the mamma, in which all the tumour below the edge of the pectoral muscle may be removed, and the disease, growing still in the upper portion, overhangs the scar or the thin cancerous stratum below that muscle. In the later stage of such cases, however, the disease gains the mastery, and cutaneous tubercles form below as well as above the ulcer. The mode in which death occurs is related in the section upon that subject.

2. The other form of primary scirrhus differs only in the mode of its growth from that already described. Having the same power of involving and spreading to new tissues, it does not accumulate its material in a central tumour, but travels superficially in all directions from its original situation. Like erysipelas or phagedænic ulceration, it spreads to new tissue and leaves that which was previously diseased. On the surface of the thorax may then be found a central red thin scar, adherent to the walls of the chest, ulcerated, and perhaps sloughy at its outer part, and skirted on all sides by low crescentic masses of outgrowing scirrhus, which are slowly advancing by fresh deposition in the surrounding healthy skin and tissues. Such cases of scirrhus appear to involve only the skin, and are sometimes described as cutaneous cancers. Although, however, they may originate in that structure, they occasionally spring from the deeper parts, and they always involve and destroy them. Of the mamma, in advanced cases, no vestige is to be found. These phagedænic cancers, as distinguished from the tumours, are among the slowest of all cancers in their progress. Two such recently died after more than twelve years' residence in the cancer-wards of the Middlesex Hospital. From one of them a tumour of the breast had been twice removed, and she had remained well for nine years before its reappearance as a spreading cancer of the kind now under consideration; the other appears to have had only the creeping superficial disease from the first. The mode of her death has been already related in the paragraph on sudden outbreaks of cancer-growth in the course of the more chronic form of the disease.

Scirrhus is, of all the cancers, the most likely to infect the absorbent glands which are anatomically associated with its site. Whether the matters conveyed to the glands, and there reproduced as an independent vigorous cancer, are taken up from the interior of the tumour, or from the healthy but infiltrated tissues, is necessarily uncertain. The materials of cancers have, however, been demonstrated in the lymphatic tubes. The period at which cancer is first formed in the glands is also uncertain; but I am led to think it to be very early indeed. I have observed them to be decidedly tender before they were in any degree enlarged or indurated. Often, indeed, if not commonly, the first change is rather a diminishing than an increase of their bulk, and a rounding of their form with bullety hardening. I have met with very few instances in which the glands were not already affected, however recent the primary disease, and with still fewer in which they were not involved at the time of death. It may have been impossible to distinguish the infiltration of the axillary glands in some examples of early scirrhus of the breast; but in the subsequent operation some cancerous deposit almost invariably appeared in one or two of them. So early do they commonly become infected that they can never be assumed to be healthy. Mr. Vincent* describes his detecting cancer as the cause of some obscure uneasiness in the throat, in consequence of observing one or two small glands, as hard as shot, in the lower part of the neck; and most surgeons have doubtless discovered the malignant nature of a stricture of the œsophagus by the same means. From the very early period at which the absorbent glands are affected, they sometimes appear to be alone, or primarily, diseased. I have never met with evidence of this alleged fact, and am induced by such an observation as the following to doubt it. Being consulted on account of some rather large and growing cancerous axillary glands, I was unable to find any trace of a primary cancer in the breast or elsewhere, until about a fortnight after the first examination of the case. At that time a scirrhous tumour, little larger than a cherry-stone, could be felt, deeply placed behind the nipple. Both mammary and axillary tumours took the ordinary course of scirrhous cancer, with the exception, that the latter throughout remained by far the larger tumour. This circumstance, however, could not be relied on as fixing the origin of the disease in the glands, since it is certain that predominance in size is not essential to distinguish the primary cancer.

The infiltration of absorbent glands with cancer renders them after a time unfit to perform their functions, and they become permanent obstructions to the course of the fluids which should traverse them. Partly on this account, and partly from the narrowing and plugging of the thin-walled adjoining veins which they occasion, the current of healthy lymph from unaffected tissues, and of the cancerous material arriving from the primary tumour, are both arrested, and accumulate behind the obstruction. Thus when the axillary glands are thoroughly cancerous and impervious, œdema ensues not only in the breast, but also in the upper extremity. An instructive contrast is then observable in the condition of these two parts. The arm becomes simply œdematous; but the fluid from the breast, being cancerous, occasions the growth of great numbers of cancerous tubercles in and beneath the skin of the whole region between the primary and the lymphatic tumours, as well as of a wide area on the side of the trunk and over the scapula. Hence arises the firm combining and matting together of all the natural tissues into the state termed 'hide-bound,' and a distressing compression of the thorax. The copious cancerous fluid finds its way by anastomosing absorbents to distant parts of the lymphatic system, and the inguinal and higher cervical glands on the same side as the primary cancer, and those in the axilla of the opposite side, become filled with cancer. Secondary tumours may then form in the opposite breast; but occasionally the lymphatic glands in that axilla become cancerous without any previous affection of the breast. This mode of the extension of cancer, by however widely spread an infiltration around a primary tumour, may be distinguished from that which is due to the carrying of cancer-material to distant parts with the blood, and from the spontaneous growing of a new tumour in a distant organ. As, however, it manifests the presence of a very large quantity of cancer-material in the part, it is equally hopeless in respect to surgical treatment as a less definitely local form of the disease.

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* *Obs. on Surgical Practice*, p. 352.

If a scirrhous cancer in an early stage of growth be cut into in the living person, it is found to require a firm incision; to become concave on both its cut surfaces; to open with difficulty unless completely divided; to bleed from its whole surface uniformly, without jet, and more freely than the textures around it; and to be incapable of enucleation. When examined after removal, it is seen to be indistinct at its surface from its union with the adjoining tissues, and from portions of the latter being prolonged a little into its substance. With the exception of being concave, the section is smooth and glistening. The hollowing or drawing in of the surface of a section is a character peculiar to scirrhus; no other tumour presents it, and in scirrhus it is not invariable. A somewhat similar central depression is observed on the uncut but flat peritoneal surface of a nodule of scirrhus in the liver. The cause of this phenomenon is not clear, but it appears to be of the same nature as that which draws in adjoining structures external to the tumour, and therefore to be especially a quality of the outermost and most rapidly growing part of the tumour. The colour of the section may be uniform, and light bluish-gray or buff-gray, according to the preponderance of cells or fibres in its minute construction, or it may be streaked with interlacing lines of fibrous tissue, or marked with yellowish dots and short stripes. Upon scraping the surface of the section, a thick creamy juice can be removed, which is bluish, or whitish, or tinted red by an admixture of blood, and is more in quantity in proportion to the bluish-gray hue of the section, as well as to the length of time which has elapsed since the removal of the tumour. It is most abundant when decomposition has commenced. Most of these characters may be also noticed in a cancerous axillary gland, the disease in it usually exhibiting much the same appearance as the primary disease in the breast. There are, however, varieties in different instances. The section of the glandular cancer is not concave. The yellow dots and lines sometimes exist only in the primary tumour, sometimes only in the glandular secondary growth. Fibrous lines are most common in the primary growth, being probably a part of the tissue of the invaded organ; and they do not occur at all in scirrhus within a bone. At a later period, the primary tumour may be much altered from its first appearance. Extravasated blood may tinge a part of the section with any of the various colours which blood assumes: inflammation may attack a part of the tumour, and, pouring into it some of the inflammatory effusions, soften and discolour it: cysts may appear in the midst of the cancerous mass, though they are more commonly found in adjoining breast-tissue, and modify with their various contents the appearance of the section: the tumour may be surrounded by a cyst, and be attached to its wall only by a broad base: portions of its centre may be occupied with colloid; and it may itself have spontaneously degenerated, and present here and there on its section buff-coloured or whitish creamy portions of so called saponification of the tumour, or of the softening already described. The partial mortifications which result from inflammation or injury, or which befall prominent and ill nourished parts of the tumour, and the changes incident to the requisite processes of repair, further modify the appearances of the section of a scirrhous tumour.

The limits of this essay do not admit of a lengthened description of the microscopic appearances of a cancerous tumour; those of a growing and of a withering scirrhus may, however, be briefly given. For an account of cancers without cells, and the various characters of different tumours of doubtful nature, reference may be made to more lengthy works upon Pathology and Histology.

I attended a woman, aged sixty-three, for cancer of the breast. When first examined, it formed a flattened, hard, nodular, superficial tumour, as large round as a half-crown piece. In the axilla was a gland of the size of a cherry. During the following nine weeks the mammary tumour trebled in size, and the axillary glands grew to a mass as large as a hen's egg. In two months more the mammary tumour had acquired closer adhesions with the skin, but had scarcely altered in size. The axillary mass was as large as an orange. During the succeeding month the tumour in the breast shrank to less than half its previous size, whilst that in the armpit grew still, and ulcerated in two places. Cancerous tubercles formed in the skin. At the time of her death, a fortnight afterwards, the primary cancer was smaller than when first examined, soft, gray on section, except in many spots, which were yellow and flocculent; the section of the axillary tumour was white and creamy.

The juice pressed from the latter tumour was entirely made up of cells, with nuclei and nucleoli. The cells were large and distinct, of various shapes, pear-like, oval, or like the outline of the os magnum. None were growing into fibres. Some of the nuclei were full of granules, but the cell and its clear space around them were very distinct. Other nuclei and cells were partly filled with granules. There were hardly any free granules, molecules, or oil-globules, there being spaces between clusters of cells entirely without them. Acetic acid cleared the cells and thickened the nuclei.

The juice from the primary tumour, which had been withering instead of growing, was remarkably different. The chief part of it was made up of free oil-globules, of various and even large size, of molecules, and granules. The cell-structures were so ill-defined as to be scarcely recognisable. There were nuclei, incomplete, as if broken, and with granules near if not in them, but no distinct nucleus and nucleolus in any part. The addition of acetic acid brought into view a few nuclei with distinct walls, single nucleolus, and a few granules, but no cell any where.

From this description it is clear that the withering of a cancerous tumour is not a conversion of it into other tissue, not a return to the healthy structure of the part, as if cancer were a mere temporary perversion of natural growth; but it is a cessation of the growing, and a destruction of the proper elements of the tumour. Cells and nuclei break up, oil-globules and granules escape. The chief element in a withering cancer is fat, which is remarkable, considering the general emaciation of the body.

The effects produced by scirrhous tumours are as various as the organs involved by them. In bones, they give rise to spontaneous fractures; in canals, to stricture, and even complete occlusion; in the brain, spinal cord, and trunks of nerves, to compression and other changes which are manifested in the anæsthesia and paralysis of subordinate parts. These and many other effects may be studied in the essays devoted to the diseases of particular organs.

For the same reason, reference may be made to those articles on the subject of diagnosis. Little need be added beyond what has been already said to distinguish these tumours. In cases in which the characters of the tumour already described raise the probability of its being scirrhous, I am accustomed to rely most upon the pain, and the condition of the absorbent glands. The former may indeed scarcely exist in an early scirrhus, but handling it brings on soreness, and a sudden, sharp, vibrating or lancinating pang, which darts from the tumour in various directions. As the tumour grows, this electric sort of pain becomes more established and more severe, often spoiling the patient's rest. It is decidedly more severe than in the softer and more rapidly growing examples of cancer, and is probably due to the compression and dragging of the nerves, as they become involved in the contractile scirrhus, and to the interstitial deposit of cancer-structures amongst and between the nerve-fibrils. A woman who was under my care in the Middlesex Hospital, on account of cancer of the uterus, suffered long-continued and severe pain in the back of one hip and thigh, with numbness and lameness of the leg and foot. The cause of her suffering was ascertained after death to have been a fusiform infiltration of epithelial cancer in the sciatic nerve.* The state of the glands, too, is almost pathognomonic, when the change characteristic of scirrhus has commenced. No innocent tumour is accompanied with a similar enlargement or hardening of the lymphatics. The only condition on which I have ever found them diseased in connexion with an innocent tumour, has been, that the skin covering it should be ulcerated, blistered, or otherwise irritated. Even in the difficult diagnosis which has sometimes to be formed between the early cystic and the cancerous disease of the breast, as well as when both are met with in the same breast together, I have always found the disease of the glands to strictly coexist with the cancer. See Diseases of the Breast.

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* *Middlesex Hospital Museum*, v. 38. The specimen is also described and figured by Mr. Flower in *Path. Soc. Trans.* vol. ix. p. 11.

b. Medullary cancer. The disease so named acquires its title from the brain-like appearance of its section. It is for the same reason as often called 'encephaloid,' or it is contrasted in respect to density with scirrhus by the title of 'soft cancer.' To certain forms or accidents of the growth are attached peculiar names, as Fungus Melanodes, or Hæmatodes, or Melanosis. The structure of these tumours, however, and the manner of their growth and life, are not essentially different from one another.

If it were not that the soft cancer is sometimes found associated with scirrhus, these two diseases might be looked upon as essentially distinct. In fact, however, they sometimes coexist and are both actively growing in the same body, or after the extirpation of one the recurrent disease in the internal organs may assume the form of the other. The sequence in such cases is always from scirrhus to encephaloid; the former never occurring as a secondary disease to the latter. And in every respect the soft cancer may be regarded as a severer disease than the hard, both arising from and implying a deeper taint of the system. It is almost exclusively the form in which cancer occurs in young subjects; it may exist at birth, and has even been met with in the fœtus.

The encephaloid forms tumours of larger size and greater number than scirrhus, is much more rapid in its growth, and more speedy in its fatal issue. It produces a greater exhaustion and a more decided constitutional cachexia than scirrhus. It exhibits none of the peculiar quality of the hard cancer of drawing towards it adjoining textures, but rather distends and thrusts them aside by the rapid and great accumulation of cancer-material in its tumours. The natural structures are therefore sometimes as much attenuated and mortified by the expansion as they are involved in the outgrowings of an encephaloid tumour. Indeed, some of them are invested and almost completely isolated from the tissues, in a distinct capsule. Mr. Paget describes such an one as having been laid bare by ulceration of the skin, and then squeezed out upon some exertion by the muscles of the back, amongst which it lay. Apparently in consequence of this rapidity of growth, medullary cancer at first spreads chiefly through the loose cellular tissue, and does not at once, like scirrhus, involve and destroy the adjoining firmer textures. It sends prolongations into cellular interspaces, or grows round organs, as blood-vessels, which are capable of resisting its aggressions for a time. Eventually, as may be well seen in the lung, they also are destroyed by the cancerous growth. When situated on the surface of an organ or cavity, it is apt to protrude and form a tumour of greater diameter than its surface of attachment. This occurs in the bladder, on the inner wall of some ovarian cysts, and rarely, but unquestionably, within some cysts in the breast, to which the name of cysto-carcinoma has been given.

The situations in which encephaloid is most commonly met with by the surgeon are the limbs and the breast. In the latter situation it is very far more rare than scirrhus; in the former, it selects the intermuscular spaces and the cancellous extremities of the bones. The eye, the testis, the uterus, the bladder, and the cavities about the face, are also occasionally the seat of medullary cancer. It forms swellings which are at first deeply seated, indistinct, and cognisable rather by local tenderness than by the amount of their enlargement, but which afterwards become masses of very considerable bulk. Except where it is covered with bone or bound by tense fascia, the mass rises towards the surface in large and sometimes numerous globular projections, which are covered with tortuous and large veins, unequal in their density, but always soft as compared with the base of the mass; they are not unfrequently so elastic as to give the impression of their being cystic. So delusive is this feeling of elasticity, and so difficult to distinguish from the fluctuation of a thick fluid in a tense cyst, that surgeons are sometimes induced to puncture one of the projections in the expectation of finding matter. The escape of blood only at the time, and the subsequent protrusion of a soft bleeding fungus through the aperture, betray the real nature of the case, and show that the Surgeon has but anticipated the natural progress of the disease.

One chief characteristic of encephaloid is its great vascularity. It is traversed by very numerous and thin-walled vessels of new formation and of enormously disproportionate size; and it appears to occasion in the adjoining structures a very great increase of existing vessels, if not the development of new ones. So commonly is the skin covering a medullary cancer marked by very large and numerous veins, that their absence may throw doubt upon the nature of the tumour. It is important, therefore, to add that the superficial veins are sometimes not much enlarged. This was the case with a boy of twelve years of age in the Middlesex Hospital, whose leg was amputated at the knee-joint by my colleague, Mr. De Morgan. The tumour was nearly as large as a cocoa-nut, and was ulcerated; but the veins, though visible, were neither tortuous nor much enlarged. Upon this great vascularity of medullary tumours, and manifestly upon the enlargement of their arteries, depends the remarkable fact of their occasional pulsation and aneurismal sound. A medullary tumour, traversed by large and thin vessels, surrounded, except on one side, by bone, and bound down by periosteum, may pulsate on that, the only side which can yield. And it does so pulsate with very considerable force, receding and becoming distinctly softer during the systole of the vessels. The most common instance of pulsating cancers is that in which the tumour is formed within a bone; and I have observed the fact in the sternum, ilium, and femur; it has, however, also occurred to me in a case in which the tumour was placed in contact with large arteries beside and externally to a bone. In some of these instances the pulsation could not be distinguished from that of an aneurism, and the operation for that disease was accordingly performed. For an account of such cases and of the diagnosis, the reader is referred to the article ANEURISM, and to the *Medico-Chirurgical Transactions*, vols. xxviii. and xxxv.

Ulceration is, in many medullary cancers, the signal for the occurrence of frequent and severe hæmorrhage, and for a rapid outgrowing of soft, fungous, blood-coloured protrusions. These are sometimes so exuberant, and their substance when examined in section is so deeply stained, that their form and character led to their being specially named by Mr. Hey *fungus hæmatodes*. Both the hæmorrhage and the overgrowing are mainly due to the great size and thinness of the walls of the blood-vessels in the tumour.

Encephaloid cancer arising in or from a bone presents a character which is never seen in scirrhus, viz. ossification in its interior. The new bone could not possibly be mistaken for the old; it grows out in long spicula and flat plates, radiating in all directions as the stroma, or spreading fibrous septa, of the growth direct it. It appears, in fact, to be an ossification of the fibres and bands of tissue which divide and subdivide the tumour. The quantity of new bone varies greatly; there may exist only a few scattered pieces, or the stroma may be completely ossified, and the bone alone retain, after maceration, the shape of the cancer. The existence of a plate of bone in the capsule was the principal indication that one of the pulsating tumours which have been referred to was of cancerous, not aneurismal, nature.

Equally peculiar is encephaloid in respect to its course. No form of cancer can be more rapidly fatal, none of longer duration. On an average of cases, medullary cancer runs its course in about two years, whilst scirrhus extends to three or four years. Isolated instances of the medullary form of disease may be more rapidly fatal than any of the scirrhous variety, or of longer duration, respectively. One case, an instance of medullary cancer in the scapula of a lad in the New York Hospital, ran its entire course in eight weeks.* In another case of multiple encephaloid tumours, a mass in the arm, which was found after death to be entirely made up of soft cancer, was told me by the patient to have existed for thirty years; a longer period, if it had been all that time cancerous, than that of any other form of the disease.

Medullary cancer in the absorbent glands is a repetition of that of the primary tumour; it is soft, usually larger and more rapid in its growth than glandular scirrhus; but on the whole less prone to take on that exclusive growth which gives to secondary hard cancer the appearance of superseding the primary tumour. The medullary disease is at least as apt as scirrhus to spread extensively through the absorbent system.

The pain of encephaloid is generally less severe than that of scirrhus, and its tumours bear an amount of handling which would occasion much suffering if they were of the hard variety. In scirrhus the pain appears to be more definitely seated in the tumour, and to radiate from it, or to extend along the nerves connected with it. That of the medullary variety seems to be chiefly the effect of the tension of the nerves and other adjoining parts; the nerves are not filled with interstitial deposit, and the tumour seems not itself to be sensitive. I recollect, before chloroform was introduced, seeing an attempt to extirpate a very large medullary cancer from the side of the neck. The girl expressed much suffering as the parts all around the tumour were cut; but when, in consequence of the impossibility of disengaging prolongations of the tumour from the transverse processes of the vertebræ, the operation was to be abandoned, and part of the tumour itself was sliced off, scarcely any complaint escaped her, and it was evident that the cancerous mass was but little, if at all, endowed with feeling.

No tumours present a greater variety of appearance upon section than those of soft cancer. Differences of structure occasion many of these varieties, and others arise from the fact that, being abundantly supplied with blood, the tumours are exposed to all the changes and accidents which great vascularity involves. The growth and the decay of the cancerous structure itself, inflammation, suppuration, effusions of lymph and serum, hæmorrhages, and all the consequent changes of tint and density of substance, diversify greatly the appearances of medullary cancers. The arrangement in lobules is commonly found to extend throughout the mass as well as on the surface of medullary cancer, and strong septa part the lobes from one another. In respect to differences of structure, it is important to observe that tumours which have not the brain-like aspect are classified by pathologists with medullary cancers, because of their likeness in microscopic structure and their clinical history. The cancers whose stroma is branched, and their name dendritic, are of this class. Some of them are firmer than the ordinary soft cancer, and are compared to such objects as udder, placenta, and potato. The "albuminous sarcoma" is probably of this nature. When scraped or squeezed, the softer varieties yield abundantly a thick creamy juice, which is in great part composed of large and numerous nuclei, with nucleoli, and enclosed in, or as frequently free from, an investing cell. The many varieties of these and of the other structures of medullary cancer may be studied in works on Pathology.

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* Gross, *Surgery*, i. 313.

Operations on medullary cancers are apt to be followed by a very rapid and destructive reappearance of the disease; yet in no form of cancer is the advantage of surgical interference sometimes more manifest. Life, on an average, is considerably prolonged by the removal, and sometimes repeated removal, of the primary tumour. With some hesitation I insert here a short history of a case in which the benefit derived from the operation was so great as to throw doubt on the nature of the disease. In the museum of the Middlesex Hospital* is the wax model of a woman's leg, the middle and outer part of which had been occupied by a very large and rapidly growing soft tumour. The section shows it to be entirely superficial to the fascia, and to be of venous-blood colour, very soft, almost pulpy, and streaked with large thin-walled vessels. The limb was removed above the knee, and in the stump there soon appeared livid blood-coloured tumours as large as plums, which rapidly grew, and could not be distinguished before or after section from fungus hæmatodes. The limb was amputated a second time, and the patient was alive seven years afterwards, and free from disease.

c. Melanosis. There is little in the structure or course of this form of cancer by which it could be distinguished, beyond the very remarkable character from which its name is derived. A tumour, otherwise medullary or epithelial, is in melanosis blackened more or less deeply with pigment, and presents accordingly various degrees of blackness, from that of jet to a mere staining, through which the colour of the tumour is distinguishable. That which is still more remarkable, and which shows the pigment to be no essential element of the cancerous structure, is that sometimes portions only of the tumour are thus tinted, and that distant parts of the body, presenting in other respects the appearances of perfect health, are irregularly stained and smudged in the same way. The blackening is due to the presence of pigment, which is partly contained within the cells of the cancer, but for the most part free. It may be supposed that this pigment, formed in the tumour, has been conveyed with the circulating blood into bone, skin, uterus, liver, or other structure, and has mechanically stuck, and then, perhaps, multiplied there. In a case of extensive melanosis in the Middlesex Hospital, in which the liver weighed nine pounds, large granular cells containing pigment were discovered with the microscope, not only in the fluid squeezed from the solid structures, but also in the dropsical serum of the abdomen, and in blood taken from the external jugular vein. They were not numerous in the latter situation, but several groups were distinctly visible.

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* See *118, 119, 120.

The most frequent situation for the growth of primary melanosis is the skin; and those tumours are the most likely to contain the black pigment which originate in or near moles already thus tinted. The eye, in which also pigment naturally exists, is likewise not uncommonly the site of primary melanotic growth. Whether this form of cancer is peculiarly common in the dark-skinned races of mankind I am not aware; but black cancers occur much more frequently in the horse and dog than in man. As a general rule, in fact, primary melanosis occurs only where pigment naturally exists.

The effect of removing the primary growth is not less favourable in melanosis than in other cancers. In a man who died under my care with melanosis of the left inguinal glands, and very many other melanotic tumours in the left thigh, liver, &c., the primary tumour had been removed from the scrotum by ligature, and had never returned. A little pigment only appeared in the white and otherwise healthy scar ten months after the secondary disease had commenced in the groin. In another case in which I removed a melanotic cancer of the anus, the microscopic characters of which were medullary, the man was at once relieved of excessive local suffering, and he passed thirteen months of healthy useful life before the disease returned in the part. He was still alive twelve months after its recurrence.

d. Epithelial cancer. The disease thus named is often known as epithelioma, or cancroid. The microscopic cells which pervade it differ much less than those of scirrhus and encephaloid from the cells of the part in or near which they grow; and their likeness to the natural epithelial structures has gained for the disease the name by which it is most commonly designated amongst British surgeons. And as its minute structure deviates least of all the cancers from the natural tissues, so its course and history exhibit in the least degree the character of malignancy. Its progress shows it clearly to be cancerous in nature, though in appearance it is sometimes scarcely distinguishable from the severer forms of lupus, and from the rodent ulcer.

Epithelial cancer is more frequent in the male, as is scirrhus in the female. Its chief primary site is the skin, especially at or near the mucous orifices; it is apparently capable of growing on or near any surface which is clad with epithelium, and it is accordingly met with on the lower lip, and lower lid, nose, anus, vulva, prepuce, and scrotum. It is found also in the tongue, on the os uteri, and in old scars, chronic ulcers, and sinuses. A specimen, apparently, of this disease was presented to the Middlesex Hospital* by Mr. Arnott; it forms a large tumour infiltrating a female breast, and in great part excavated by an uneven papillated cyst. The cavity was filled with a thick closely-packed mass of epithelial scales, and the disease appears to have originated in the mucous ducts. The cauliflower excrescence of the os uteri is of the nature of epithelial cancer, and the name well illustrates the manner in which its constituent structures are fissured and parted from one another, even to its root. On the scrotum it forms the well-known chimney-sweeper's, or soot, cancer of Mr. Pott.

Epithelial cancer makes its first appearance in various forms. In a recent case at the Middlesex Hospital,† it grew as a warty excrescence from the nose, and spread slowly over the centre of the face until it reached the size of half a swan's egg, when the patient died. The entire surface of the growth was made up of separate pedunculated rounded tumours no larger than peas, and covered with thin integument. Occasionally the surface of the growth is thickly set with straight, short, and stiff papillæ. Sometimes there is little apparent but a fissure, covered with a dry scab; and on pressing it the fissure is found to be a cleaving of a superficial but firm, or even hard, thickening of one of the mucous orifices. It may form a single pedicled outgrowth, or may be an infiltration of all the superficial structures, which assumes the shape of a flat, firm, sessile tumour. In the tongue it is now and then found to be deeply lodged, of considerable size, and, only as it enlarges, to approach the superficial epitheliated membrane.

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* See *Catalogue of the Museum*, xviii. 20, and *Trans. Path. Soc.* vol. ix. p. 385, where the tumour is described by Dr. Van der Byl.

† See *Catalogue of the Museum*, *121.

The entire substance of all these growths is microscopic cells, which present the flattened form, the angular outline, and delicate nuclei of those of tesselated epithelium. Some are of very large size; others do not exceed those of natural structure. They cluster so as to form conical and other papillary shapes; some take the relation to the smaller scales of mother- or brood-cells. Differing but little in appearance from ordinary epithelium, these cells hold a different relation to the natural tissue. They do not clothe its surface, but, after the manner of true cancer, they infiltrate and destroy the deeper parts, originating even in the midst of textures with which they have no natural relation.

Like true cancer, the epithelial growth softens, ulcerates, or sloughs, and a characteristic ulcer is the result. It is apt to be covered with a creamy juice, which hides the pale pink surface of the sore, the pea-shaped tuberous granulations, and the deep fissures which part larger inequalities and bulging outgrowths of the ulcer. The edge is thick and often raised, and a thin cicatrix not uncommonly advances far over the sore. A whole ulcer may thus cicatrise, and fresh ulceration subsequently take place in some adjoining portion of the tumour, or some entirely separate deposit. The appearance sometimes presented on the skin is hence very varied; as on the leg, the greater part of which may show, with many present epithelial ulcers, the marks of much previous, but now scarred, ulceration. In many cases the outgrowing of the cancer and its limitation to surface soon cease, and the disease advances and ulcerates deeply. The subsequent destruction of the natural tissues is occasionally very extensive; one cheek and half the jaw, or the entire tongue, or the whole thickness of a tibia, or all the structures composing a joint being removed by it. It tends early to infect the subordinate glands, at first rendering them hard, round, and bullety, but afterwards growing to enormous soft tumours, in which all trace of gland-structure has long been lost. These, in turn, ulcerate at one or more points; but the small external opening, with its bulging edge, is seen to be the outlet of a large cavernous excavation, which eventually, as the ulcer widens, is laid broadly open. The epithelial is less apt than the other forms of cancer to be limited in the lymphatic system to one chain of glands. It is also peculiar in being rarely disseminated beyond that system into distant organs. When that occurrence does take place, the form of the diffused disease is, as a rule, the medullary. The fatal result is almost always due to the secondary glandular affection, the excessive growth and widely spread ulcerations of which exhaust the system much more than the smaller primary tumour.

The growth of new blood-vessels and the enlargement of those already existing, which occasion the great vascularity of some cancers, almost only occur in the medullary form of the disease. This fact has been referred to in the observations on *fungus hæmatodes* and the hæmorrhages of encephaloid. I have, however, once seen in an unquestionable case of epithelial cancer of the lip a growth of vessels and a liability to copious bleedings, which might have characterised the disease as medullary. The whole skin of the front of the neck and upper half of the thorax became a vast purple nævus, uneven from the bulging of large vessels, soft and impressible as a varicocele, and presenting no trace of the natural hue or thickness of the cutis, except at its edges, where it blended irregularly with the unaltered integuments. The patient was an old man, and the whole nævus formed in a few months, under my own observation.

Both in its long average duration and in the numerous instances which it presents of a considerable interval between the time of excision and that of the return of the disease, epithelioma manifests a less pronounced malignancy than the other forms of cancer. Mr. Sibley deduces from the Middlesex Hospital records,* that, on an average, the epithelial cancer destroys life in fifty-three months, while scirrhus lasts but 32·25 months. The fact, regarded alone, might seem to be accounted for by the rare occurrence of secondary epithelial cancer in the vegetative organs; but when the familiar observation is added, that many patients, from whom this form of cancer has been removed, remain for years without any recurrence of it, and that recurrence is not usual in the scar, the conclusion seems fair that it is essentially less inimical to life. One reason of the comparative immunity of the superficial parts from a recurrence of the primary growth may be that the latter, being usually but shallow, is often completely extirpated.

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* *Med.-Chir. Trans.* vol. xlii. p. 125.

The epithelial is the only form of cancer in which the origin of the disease has been satisfactorily ascertained to be associated with a previous morbid state of its site. Instances are quite common in which it unexpectedly appears in parts which have been long subject to irritation, or have been the seat of unhealthy and ineffectual attempts at repair. My colleague, Mr. Shaw, has published an instance in which epithelial cancer suddenly appeared in an issue which had been kept open for thirty-five years.

In another instance, he amputated the arm of a gentleman, aged thirty-five, for epithelial cancer which had suddenly invaded an old diseased elbow-joint. The original disease dated from the patient's childhood, and had long appeared to have ended in anchylosis, a small fistulous opening only occasionally discharging matter. Upon a sudden and painful enlargement coming on, Mr. Shaw removed the limb, and found bones and soft parts alike removed and replaced by epithelial cancer. The disease returned in the axillary glands, and the patient eventually died. A brief notice of a similar occurrence is given by Mr. Gay, in the 2d vol. of the *Transactions of the Pathological Society.*

Mr. Oliver Chalk successively amputated both the lower limbs of a man in whom bunions, after remaining for many years unhealed, had become affected with epithelial cancer.

The following case illustrates the same fact. I add some of its details for the purpose of showing also the possibility of the complete subsidence of the primary disease. The parallel circumstance has been already related of scirrhus. Its occurrence in medullary, the most malignant of the cancers, is doubtful, or at any rate extremely rare. A sallow man, aged thirty-five, was under my care in the Middlesex Hospital for a large ulcer of five years' duration on the right leg. Its vertical extent was five inches, and it occupied all, except the inner side, of the circumference of the leg. It had the ordinary characters of a vast chronic ulcer, except at the outer and lower part, where, and where alone, the granulations were elevated into tuberous hard projections, and the edge was thick, swollen, everted, and red, quite unlike the white callous edge which skirted the rest of the sore. Below that part of the ulcer which appeared cancerous, the skin was harder than elsewhere and raised in a few nodules. The thigh was œdematous, the leg slightly so, and in the iliac region could be felt a mass of enlarged and hard glands, as large as a hen's egg. The urine was albuminous. In the course of five months of treatment, the urine ceased to contain albumen, the nodules and swelling of the granulations and skin, which had been unmistakably cancerous, disappeared, and the sore entirely healed. But in the same period the glands in the groin doubled in size; one or two of them became as large as walnuts, and the œdema greatly increased, distending the entire limb. Mr. Pollock, of St. George's Hospital, informs me of an instance of the entire subsidence of what appeared to be cancerous infiltration of the inguinal glands, subsequently to his amputating in the thigh on account of a primary epithelial cancer of the leg.

e. Osteoid cancer. It has been stated in the description of encephaloid cancer, that the stroma of that growth is sometimes ossified, and traverses it in the form of radiating plates and fibres of bone. Examples of ossification have also been mentioned as occurring in tumours originally fibrous, cartilaginous, and myeloid, as well as in others. Osteoid cancer, however, differs from all these. In a well-marked case the primary tumour is a large mass of the hardest enamel- or ivory-like bone: the glandular disease is bony, though it may be less hard; and the disease disseminated in the soft internal organs, and protruding into the blood-vessels, is also in great part osseous. The surface and patches in the interior of the primary growth may be unossified, and composed of the very densest fibrous structure. The first tumour is usually single, slightly uneven on its surface; its section, though in parts fibred, is mostly solid, unbroken, and unmarked by Haversian canals: the secondary growths are commonly in many pieces, and separate or crumble to pieces after maceration. The bone is quite white: its microscopic elements are in some parts arranged in the manner, but not with the perfectness, of true bone.

Regarded in connexion with the disseminated fibrous and cartilaginous growths referred to in the article TUMOURS, this rare disease presents much interest in relation to the nature of cancer and its capability of being diffused over the system. It is clear that a power of dissemination is not limited to a cell-structure, and that whatever be the substance which is conveyed from the primary growth, the secondary tumour may assume the characters of the first, though neither be of the ordinary cancerous structure, or may return to or deviate from the usual cancerous type. Langenbeck informed Mr. Paget, that he "once removed an upper jaw with a bony growth, and the patient died soon after with well-marked medullary cancer in the lungs," and that "he once removed a humerus with a medullary cancer, and the patient died with osseous tumours in the lungs."* This interchangeableness of osteoid and encephaloid manifests yet more clearly the cancerous character of the former disease.

Primary osteoid cancer occurs usually in bones, and more commonly in the lower end of the femur than elsewhere. It may occupy the interior or the exterior of the bone, or both parts. Some such tumours have been met with in the interspaces of the structures in the limbs. Its growth is usually rapid and very painful. Mr. Paget describes a case in which death took place three months and a half after the discovery of the primary tumour, but refers to seven others which were operated on, in two of which the disease was fatal in the first year of its existence, in one in the second, and in one in the third, whilst one of the seven patients lived seven years and a half, another for twenty-four years, and another for twenty-five years. The evidence is decidedly in favour of early and of repeated operations in this disease.†

Of *villous* and *colloid* it is not easy to speak as cancer. In regard to the latter, pathologists have not agreed amongst themselves as to the diseases which should be included under that name. Many authors speak of it as a variety of cancer, and as sometimes concurrent and interchangeable with medullary cancer, as even forming one part of a tumour which is elsewhere malignant; others, and particularly Mr. Sibley,‡ not denying the latter fact, restrict the term to cases which they find capable of classification by their microscopic appearances, and not prone to multiply, or to infect the constitution. The characteristic of its construction is a very delicate translucent membranous stroma, which is chiefly, if not entirely, composed of the former tissues of the part, and is coiled around spherical spaces, varying in size from that of a blood-corpuscle to that of a hen's egg. Out of these spaces can be turned a clear, sometimes coloured material, as various in its consistence as glue, and having for the most part a plainly perceptible kernel, or central body, composed of granules, or of many, simple or nucleated, spherical cells. The growth of colloid is rapid, and in certain situations, as in the peritoneum, may reach an enormous bulk. The parts in which the Surgeon chiefly meets with it are the rectum, parotid region, and breast. Its occurrence is most common in the intestinal canal, where it is also commonly known by the names, Gelatiniform or Alveolar.

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* Paget, *Surgical Pathology*, vol. ii. p. 504.

† See, on the whole subject, Paget, loc. cit. p. 495, and Handyside, *Osteosarcoma*.

‡ *Med.-Chir. Trans.* vol. xxxix. p. 259.

In Nov. 1855, I extirpated the breast of a Creole, on account of one of these tumours. The woman did not know her age, or much about the duration of the tumour. She appeared to be about thirty-five, and she thought the disease had existed twelve months. In her right breast was a hard, much nodulated, tender tumour, flattened toward the chest, and apparently covered by nearly the whole mamma. This organ was lax, and moved loosely over the tumour, though the latter did not slide freely upon the pectoral muscle. The nipple was quite healthy and free. She had occasionally felt shooting pains in the tumour, but no severe suffering of any sort. She could bear it handled, but not to be pinched or raised. On section, the mass was solid, uniform, of a dark pancreatic colour, without fibres or juice. It was firmly adherent to the pectoral muscle, of which I removed a considerable layer, and which seemed attached to it as seaweed to a rock. The microscopic appearances were those of colloid only. No cancer-elements existed; yet the disease is reported to me to have returned in the manner of cancer, and she died of it in Jamaica in 1859.

Recurrence is a common character in cases of this disease; in most of the known examples it has been local only, an insufficient ground to establish the cancerous nature of the growth. Such an instance* was described by my colleague, Mr. Flower, in the *Transactions of the Pathological Society*, vol. x. p. 256. It was removed by Mr. Douglas, of Hounslow, from the inside of the leg, below the knee, of a married woman, aged sixty-one, where it had grown in fifteen years to the size of a cocoa-nut. It was deeply lobed, elastic, incapsuled, and painless, but required removal on account of ulceration of the skin covering it. It dipped between the muscles of the calf, without being connected to them, but was closely attached to the deep fascia. A section of the tumour exhibits the simplest colloid structure, strong septa parting off from one another globules of clear or tinted semi-transparent jelly. The whole tumour was clearly removed; yet within a year the disease recurred in the scar, and a second tumour, a miniature likeness of the first, has been removed. Not the least trace of glandular disease exists in this instance: in colloid of the breast that occurrence has been observed.

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* *Museum Middlesex Hospital*, xx. 37, 37 a.

Villous growths claim a few remarks in this place, inasmuch as they have been described as of malignant nature. Their title to that character is, however, in as much doubt as that of colloid, and I have hesitated to include either amongst the cancers. True villous disease is, both in its general appearance and under microscopic examination, extremely like the chorion, differing little from that natural structure except in the coarseness of its mesh-work and flask-shaped papillary projections. In no specimen which I have examined has any cancerous material been mixed with it. It springs by a pedicle from surfaces, and in some specimens contained in the Museum of the Middlesex Hospital* its sites are the mucous surface of the bladder, the knee-joint, the interior of a mammary cyst taken from a bitch, and the colon. In the last named organ the disease covers nearly the whole of the mucous membrane, and its true character is only demonstrable by the microscope. Mr. Quain, however, has published an account of two cases of hæmorrhage from the rectum, which arose from non-malignant tumours of this nature. The ascription of malignant characters to villous disease appears to have chiefly arisen from its external similarity to medullary cancer of the bladder. Both diseases grow from the vicinity of the opening of the ureter; both project wholly into the cavity of the bladder; each may have a narrow or a broad pedicle; neither is necessarily single; the amount of secondary disease associated with the true cancer is so small as to be easily overlooked, and confounded with its absence in the villous disease; and the mode of death from the two affections, viz. by hæmorrhage and disturbance of the urinary organs, is the same. The true cancer, however, has none of the villous structure. It is a soft, highly vascular mass of medullary cancer, seldom lobed, sometimes smooth, occasionally having shreds hanging and floating off from its surface. These shreds, however, are entirely without the villous character. It does not appear that the medullary and villous diseases have been clearly detected in the same tumour, or that any of the vesical cancers present the dendritic mode of growth which is sometimes seen in medullary cancers elsewhere, and which has been described by Rokitansky. The dendritic cancer is to be clearly distinguished from the villous tumour. The former is sometimes distinctly associated with other medullary tumours, but that connexion, if it ever exist, has yet to be clearly established in respect of villous disease. The only apparent union of the two diseases, which I am aware of, is one of cancer of the intestine, lined with a hypertrophied mucous membrane. (See Diseases of the Bladder; Rectum.) The distinctions between villous disease and cancer may be advantageously studied in papers by Mr. Sibley in vols. vii. viii. ix. of the *Transactions of the Pathological Society*.

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* See *Catalogue*, iv. 55; viii. 14 b; xi. 8 c, 35, 36; xxi. 6.

On the mode of death in cancer. The fatal issue of this disease is sometimes directly and sometimes only indirectly brought about by it. In a few instances, death is said to have been occasioned by a degree of constitutional disease or cancerous cachexia quite disproportioned to, and independent of, the amount of the morbid material found in the body. I have never met with such a case, but have always observed that those patients who have died with much sallowness of the countenance, much diffused pain, with loss of appetite and emaciation, have been suffering from extensive internal secondary cancer, especially in the liver and other vegetative organs. The supposed cancerous taint of the blood in such cases is undefinable. That portion of the animal frame is as deficient as the solid organs, and contains no appreciable element of cancer. When cancer reproduces itself in great abundance, either externally or internally, the cause and manner of death are usually sufficiently manifest: the disease makes increasingly rapid local progress until the powers of the system are worn out. The body becomes emaciated while the cancer grows, and by the exhausting and sometimes frequently repeated hæmorrhage, the exuberant growth, the discharge, pain, sleeplessness, and inability to assimilate food, is more and more reduced. Last of all, as the strength finally sinks, the cancer itself may be in great part absorbed, and contribute its substance to prolong the weary life. A marked sallowness is then added to the previous paleness of the countenance, and, fainting or slowly exhausted, the patient dies.

Cancer-patients are always much reduced in strength by any sloughing in the primary or the glandular tumour; and if it be at all extensive, they may not recover from it. Death from this cause, however, is rare.

The modes of death not directly issuing from the cancer vary much. Erysipelas and blood-poisoning (pyæmia) destroy some patients, whose disease in pure air might be compatible with years of longer life. There is no canal in the body which may not be obstructed or constricted by cancer; and, if essential to life, the closure of it may be fatal. The alimentary canal thus obstructed in its lower part, or the urethra by vaginal cancer, may be relieved by a surgical operation. I have had the opportunity of prolonging life under both these circumstances. An obstruction in the higher parts of the intestines is necessarily fatal, being incapable of relief by surgical means; thus, the duodenum has been fatally compressed between enlarged cancerous glands. Some patients die of jaundice, from the obstruction of the ductus communis choledochus; and some from starvation, in whom cancer of the tongue, pharynx, or œsophagus prevents swallowing, and nourishment cannot be conveyed into the system in sufficient quantity by enemata, or by a successful operation of gastrotomy.

Cancer is also fatal by laying open, as well as by obstructing, the canals of the body. The œsophagus thus sometimes communicates with the trachea, and when the patient dies with exhaustion and pneumonia, portions of food are found in the air-passages of a lung. I have known the jejunum to adhere to a cancerous vagina, and, being opened by ulceration, to discharge its liquid contents incessantly into that canal, and occasion an incurable and exhaustive diarrhœa. The ulceration of uterine cancer into the bladder or rectum entails consequences which much hasten the fatal issue of the disease. Arteries may be closed by advancing carcinomatous growths, and limbs mortify in consequence; they may also be ulcerated by the disease, and the patient die of violent hæmorrhage. Various mortal changes may take place in organs whose nerves are involved in a cancer distant from the organ itself. Cancer of the nervous centres is generally fatal in the same manner. Death may arrive by the pleura, the glottis, by any important organ of the body indeed, if involved in this disease. And, finally, the cancer itself may disappear, but only as it is supplanted by an equally fatal growth of tubercle in some internal organ of the body.

Nature of cancer. In the period of uncertainty, before careful and extensive observation had defined the limits and habits of true cancer, the most unfounded notions were entertained as to the nature of the disease. The opinions which are worth referring to are, that cancer is a poison; that it is a parasite; and that it is a perversion of nutrition of a part, or the whole, of the body itself.

1. That it is a poison, seems not unlikely, if we regard some only of the circumstances connected with it. The majority of cancer-patients have been remarkably healthy persons, up to the time of the appearance of the primary tumour. The interjection of a disease so vigorous and destructive, in the course of a very healthy

life, suggests the probability of its origination without the body. And the great power of multiplication exhibited by cancer accurately corresponds with the same character of acknowledged poisons. Small-pox, cow-pox, and other infectious and contagious diseases, are capable of being conveyed by a very small, even by an inappreciable, amount of poisonous material; but, when communicated, that material may be multiplied in the infected person a millionfold. The opinion in question, however, is not supported by other known facts. As such, cancer is not communicable. It may, indeed, be transferred from one part to another of the same patient. It may, for instance, be implanted across a serous or other cavity, from a diseased to a previously healthy surface. But amongst the myriads of occasions on which the disease might, if communicable, be transferred from person to person, no appreciable proportion of examples of the transfer of cancer has been observed. Nurses do not become inoculated with it: cancer of the penis is not common enough to have been received in coition: Surgeons have been extirpating cancers from the time of Hippocrates, but there is no instance of the disease being communicated to an operator. The experiment of injecting fresh cancerous fluid into the tissues of the lower animals has occasionally but very rarely been followed by the development of cancer; as this, however, is a practice to which human beings are not subjected, and it is not asserted or supposed that cancer thus originates accidentally in them, it is needless to argue against such a mode of conveyance. Moreover, the notion of the origin of cancer in an accidental poison is inconsistent with the facts relating to its transmission by inheritance, and with the exemption of some whole families from the disease. Were it inoculable, it might be also capable of modification by the same means; by the injection, for instance, of the elements of one form of cancer into another.

2. That cancer is a parasite, could only be surmised while its minute structure was unknown, and when the semblance of an independent life and of a spontaneous reproduction of itself could not be otherwise explained. Cancer is no intercalated organism, like a trichina or a hydatid; in, but not of, the body. Up to a certain point its growth is like that of tissue, and there are in it recognisable elements of cell, blastema, fibre, oil, granulation, cicatrix. The blood nourishes it, by newly-formed vessels; feeling and the nerves associate it with the brain. In its modes of growth also it sometimes resembles other diseases, and shows a common subjection with them to conditions which, as they are not essentially and

exclusively cancerous, cannot be parasitical. Thus, it sometimes spreads superficially, like phagedæna, healing where it first began; healing and spreading, in fact, at the same time. Or it shares with the fibrous recurrent tumour a power of reproduction and of recurrence in other parts, which must cause both to be considered of animalcular nature, if it be admitted of either. To some extent, but that a variable one, its vigour of life is subordinate to certain local and general influences; to the vascularity of its site, to the youth or age of the patient, to pregnancy and lactation, to the coexistent health or disease of the patient—all which influences will be referred to elsewhere.

3. That cancer is a growth *of* the body, though a perverted and morbid one, is borne out by the analogy of other tumours, and is certain when its minute structure is demonstrated. Amidst much that is confusing and difficult to define under the microscope, there yet are in every growing cancer elements answering to those which occur in other parts, and still more at earlier periods of the life, of the body. Many of the cells are indistinguishable from those of the liver; and so similar are those of one form of cancer to natural epithelial cells, that the likeness has given its name to that disease. Nuclei and nucleoli are not exclusively cancerous, though they are so when taken from parts of the body to which they do not naturally belong, and when found in such numbers as in some specimens of medullary cancer. The same observation is true of the fibres, granules, and corpuscles, the pigment, bone, and oil-globules; all are sufficiently like natural structures of the body to show therein the proof of a like origin. Moreover, the continuity of substance, though not an absolute proof of the identification of a cancerous tumour with the organ in which it lies, is proof, so far as our present knowledge reaches. Parasites are never continuous with natural tissues, however closely wedged in amongst them. Even the placenta is separable from the uterus. A cancer, however, though in great part surrounded with a capsule, is rarely or never so isolated; and much more frequently it is infiltrated, and is in that respect as ink to blotting-paper, or albumen boiled in a sponge.

Although composed of elements which are not entirely foreign to the body, cancer is in every other respect foreign to the part in which it grows. It is untimely, since for the most part its structures are embryonic, and are interposed amongst those which belong to later life. It is imperfect, for no extent of growth brings it to the condition of adult structures. It tends in no way to fulfil the purposes for which the organ it invades was designed. It is, on the contrary, destructive to the natural pre-existing parts, which, without exception, though with varying rapidity, become lost in the tumour.

Origin of cancer. As this disease is observed habitually to originate in one place, and to spread in it and from it with some appearance of order, a distinction is recognised between the first tumour and those which succeed it, the former being commonly spoken of as the primary, the subsequent as secondary, cancer. Very few exceptions to this order even appear to occur: that they do so cannot be admitted upon the present evidence. The apparent occurrence of double primary cancers has already been referred to in the section on the epithelial form of the disease. In the instance of scirrhus in both mammæ, a sequence can commonly be satisfactorily established, the second breast being infected by infiltration from the previous disease on the opposite side. Cancer has been noticed in both eyes on some few occasions. This occurrence is not quite certainly explicable by the anatomical relations of the two organs, although the optic nerves, by which they are closely associated, are prone to early infection; but, an interval of months having elapsed between the origins of the double disease, the ordinary sequence was probably preserved, and the secondary tumour occasioned in one of the usual ways, by the diffusion of cancer from the first.

This sequence is so habitual in cancer that patients and even Surgeons sometimes appear anxious to assign some blow or sudden injury as the cause of the primary tumour. The impression that cancers do sometimes so originate has even led to the attempt to prove that they are but transformations of ecchymosed blood. No reliance can be placed, however, upon the notion, or its supposed proof. It is true that in extremely rare instances an injury has been followed by a rapid growth of cancer; but the occurrence has not been more frequent than might be accounted for by the accidental concurrence of the injury with an imminent outburst of cancer in a person predisposed to that disease. The patients in such cases were young, and the form of cancer the medullary. Such a mode of origin is never suggested for the primary cancers of internal organs, or for any of the multitude of secondary tumours which readily succeed the formation of the primary. In the vast majority of cases the first tumour is known to have formed without previous injury of the part, or is found to have already attained an appreciable size when the accidental hurt first calls attention to it.

The injured spot is commonly that in which the cancer is apt to originate spontaneously: the medullary cancer in the eye or testis is just such as would spring up in those organs without the assumed occasion of blow or wound. The sequence of events afterwards is precisely the same, whether there be or be not in the history of the case the coincidence of a blow with the first observation of the disease. On the whole, it may be assumed that the primary disease originates, as it afterwards spreads, or as the smaller tumours near it subsequently form, by a spontaneous conversion of the nutriment or blastema of the part into a new growth, and its intercalation among the existing structures. The earliest and latest observations of cancers are alike in this respect. Tissues may be ascertained in an operation to have all the visible and tangible qualities of health, and yet cancer may afterwards form in them: there is, therefore, on the whole, no sufficient reason for the invention of a different mode of origin for the previous tumour.

But while it is asserted that a single sudden injury is not the occasion of a cancer-growth, it is not therefore necessary to ignore the many instances in which that disease originates in a part which has long been subject to, and probably weakened by, mechanical irritation. The proximity of a broken tooth to one spot on the tongue, the habit of carrying a clay-pipe on the lip, the long-continued contact of soot with the skin, and the retention of the secretions of the glandulæ odoriferæ beneath a contracted prepuce; these and similar sources of prolonged irritation, are at least suspected of so altering the mode of life of the part as to arouse a supposed dormant capacity for cancerous action. The form of the cancer so originating is always the epithelial, that which least manifests the malignant character; and in the section on that disease, some interesting examples are given, in which it attacked parts which had long been the site of previous simpler morbid processes.

It is a question often asked respecting the mode of origin of cancer, whether tumours of innocent nature can become cancerous. This seems equivalent to the inquiry, whether an oak ever changes into an elm. The extreme rarity of the instances in which the question arises goes far to furnish a reply to it, and to show that innocent diseases have at least no special proneness over the rest of the body to become malignant. They have even been observed to show a less proneness; as when cancer fails to attack an already existing chronic mammary tumour, but forms a separate tumour in another portion of the same breast. The cases in which cancer certainly does select for its site an innocent growth are those in which melanosis first appears in warts, and epithelioma in ulcers, scars, and chronic scrofulous fistulæ. Sir B. Brodie mentions an instance in which he removed a fatty tumour, containing scattered cancerous nodules. There does not seem to be any *à priori* reason why cancer should not first occur in an innocent tumour; but this must not be regarded as a natural issue of an innocent growth. The cases in which it seems to have taken place may possibly be those in which an hereditary cancerous taint fades in transmission into a mere tumour-growing propensity, but reasserts its malignant power as life advances.

Dissemination of cancer. Some cancers never spread beyond the part in which they first grow; and there is every gradation in the extent, and every variety in the method, of the dissemination of others through the organs of the body. Of the reason of these differences we are quite ignorant, and must probably remain so until the nature of the material which is disseminated is discovered. It is observed that, as a general rule, the diffusion of those cancers is the rarer, which either have by their position, or by early ulceration acquire, a free outlet for their pervading liquids or blastema; whilst the cancers which are pent within organs appear to shed their growing blastema into adjoining healthy tissues, and to set up in them, and furnish means to the circulation for, new and similar growths. The cancer at the orifice of the womb, which appears to excite much uterine contraction, and which yields a copious discharge, and the soft tumour which projects wholly into the bladder, is constantly soaked in urine, and sponge-like is often pressed by the muscular coat of that viscus, may be contrasted in this respect with the compact and deep-seated cancer in the breast. Secondary cancer is formed in seventy-nine per cent of the latter cases; of the former in certainly not more than twenty-five per cent.

But though this may be stated as a common rule, there are facts which appear inconsistent with it; for there are covered cancers, though very few, which remain solitary to the end of life, and there are cancers on free surfaces which do become disseminated. The difference which has been stated is nevertheless very decided, and is probably but partly explicable by the early mortality of uterine and vesical cancers, and their consequent inability to spread to other parts of the body.

In the present state of our knowledge it is not possible to define the manner in which cancer spreads throughout the body after the growth of the primary tumour. The order of its extension is not uniform. Neither proximity nor the ordinary channels of circulation wholly determine it. The secondary does not imitate the primary growth in the selection of its site; nor does difference of kind or of structure amongst the cancers produce any clear deviation from what might be assumed to be a rule of dissemination.

It is to be here observed that that which spreads is cancer. There appears to be no elimination, little alteration, of the deadly material. From tumour to lymph-gland, from gland to liver or bone, and from these to glands again, there is a repetition of the same structure, increasing it may be in malignancy of type, but equally free from a marked modification by the tissue it comes to occupy, and by the organs and blood through which it has passed. In respect to the question and mode of its passage the following hypotheses may be examined:

1. Secondary cancerous tumours are formed, without dissemination, independently of the pre-existing one. This hypothesis might be accepted, if the later growths showed the same habits as the first; but they commonly select a different site from the primary tumour, and run a different course. In one-half of the cases of cancer the disease restricts itself to one tumour, or elects for its further growth the subordinate lymphatic glands. The only instances in which I could suspect the occurrence of more than one primary tumour in the same person were two cases of epithelial cancer. One was under my own care in the Middlesex Hospital, a case of coetaneous open cancers on the lower lip and side of the nose of the same man. The other, also a patient at the Middlesex Hospital, was under the care of my colleague, Mr. Henry. The man had an epithelial cancer of the leg, without affection of the absorbent glands in the groin, and subsequently cancer of the same kind in the tongue, with disease of the lymphatics in the neck. The rarity of such occurrences makes more striking the rule, that secondary tumours do not occur in the usual sites of the primary disease. Secondary scirrhus in a mamma happens only in circumstances which make it plain or probable that it is a growth by continuity with that in the other breast, and not by dissemination.

2. Cancer is conveyed from the primary tumour by continuity of tissue. This is partly true, for it explains all the extension of the primary tumour through an organ or region, whether there be or be not apparently healthy tissues between the principal and the adjoining tumours. When two organs are unnaturally ad-

herent, the cancerous growth of one sometimes passes across the adhesion and becomes implanted in the other organ. Thus I have seen the only cancer in a lung to be a small portion of an outgrowing cancerous gland of the posterior mediastinum, and the only infected absorbent in the root of that lung to be one of considerable size, not more than an inch from the implanted cancer.

3. Cancer travels in the course of the circulation. To some extent this is true. When it is repeated in the glands of the part in fourteen out of seventeen cases, there can be no question of its reaching them by the absorbents; and by some pathologists cancer of the glands is not looked on as secondary, but as a part of the primary growth. Moreover, while there is no retrograde extension of cancer in the lymphatic system, *i.e.* against the current of the lymph, there is a progress of the disease from near to further glands, which proves a direct transmission. The early, the frequent, and the often exclusive, infection of the glands is one of the most clearly established facts in the dissemination of cancer, and manifests a decided selection of the lymphatic system, rather than the veins of the tumour, for the spread of the disease. There are indeed rare and remarkable instances in which cancer appears as a secondary deposit in internal organs, while the intervening lymphatic glands connected with the site of the external primary disease remain perfectly healthy. The fact is noticed about once in every forty-three cases of fatal cancer, and is at present inexplicable: it is too rare, however, to throw doubt on the prevailing fact that cancer spreads first by the lymphatics.

When the diseased material has traversed the glands and thoracic duct, and reached the venous system, the next organ in which cancerous deposits might be looked for is the lung; and, as being the earliest tainted, it should exhibit the largest and most numerous, as well as the most frequent, secondary deposits. Yet it appears that whilst the absorbent glands were affected in 140 cases out of 173, the lungs, the next in order of the capillary systems, were cancerous only in twenty-two.

Following still the course of the circulation, we ask if the remaining organs of the body, to which arterial blood flows alike, are not equally prone to secondary disease. The answer is negative. In these parts of the body there is the greatest irregularity. The serous membranes are much more frequently affected with secondary cancer than the lungs, the spleen and kidney far less commonly than the bones. But above all other organs rises the liver in its liability to secondary cancer. It is attacked in 60 out of 173 instances taken indiscriminately, but in 60 out of 90 cases in which the disease spread at all beyond the lymphatic glands of the part. Its liability to infection is strikingly brought out by its contrast with the lungs. It receives, like them, both venous and arterial blood, but, unlike them, is rarely fed at first hand by blood which is infected. The portal blood arrives from organs which are comparatively seldom cancerous; the pulmonary blood from all the other organs of the body, in which the great majority of the primary cancers occur, as well as from the absorbent system. In advanced cases the diseased liver itself should, upon the hypothesis, send cancerous infection to the lungs; yet, on the whole, the latter are found thus diseased but once when the former is infected thrice. It would appear, moreover, that, not merely as an ordinary eliminating organ, but as one having a special affinity for fat or some cancerous excretion, the liver is thus prone to the secondary disease; for the kidney is attacked with consecutive cancer but twice in 173 cases, and the spleen, though seemingly so intimate an associate of the liver in function, but once.

Although, when the disease is disseminated through organs remote from the primary tumour, the liver is not invariably attacked, yet its great proneness to secondary cancer, and the apparently vital connexion with that disease which it assumes, are further shown by the following observation. In other secondarily affected organs the tumours are often few or small, but cancer in the liver is a most extensive disease. One half or the whole of the organ is studded throughout with small nodules, and destroyed in great patches by masses of cancer. A solitary tumour is rare: the organ seems mostly affected as a whole; for the tumours often grow so thickly in it as to be nowhere an inch apart. Only in the skin is this profusion of separate cancerous tumours equalled, and if in the liver it might be explained, as that in the skin is, by the infiltration of cancer-blastema from an adjoining previous tumour, yet the manifest selection of the liver rather than of other internal organs by the cancer, and the great accumulation of that growth in it, remain unexplained.

4. Is the material of cancer carried, as pus is supposed to be carried in pyæmia, and arrested by the accident of its size, in one or another vessel? Of such a mode of conveyance of cancer we are without proof. If its material were taken up in mass by the absorbents and veins of the part, it should be seen in them, and should be first and oftenest arrested in the lungs; if by the arteries, it must be separated from the walls of the larger to be carried into the smaller

vessels. The evidence already adduced to show the rarity of secondary cancer of the lungs negatives the former supposition, and the entire absence of demonstration is a sufficient proof that the latter does not occur.

On the affinities of cancer, and its limitation or control by external agencies or other diseases. No fact is more commonly observed in this disease than its apparent independence of the functions of the body. The various appetites continue during its early stages, neither interrupting, modifying, nor being themselves altered by it. Hunger and thirst, pregnancy and lactation, and ample nutrition of all parts of the body except the affected organ, may go on, if only the cancerous tumour do not mechanically prevent the performance of the function of the organ which it occupies. The disease appears to grow with as self-dependent energy as a fœtus in the uterus, but, unlike it, is subject to irregularities, and even complete intermissions of growth. By what these variations are occasioned is for the most part unknown to us; and it is the more difficult to define their cause, as they occur in different cases under some quite opposite circumstances. Of such circumstances, therefore, they are plainly independent.

Speaking generally, we may say that the cancer of the aged is chronic, and that of the young is vigorous and rapid in its growth. Yet this is not universally true; and if it were, the rule could not thence be drawn that the vigour of the disease is measurable by that of the system in which it occurs. Its victims at every age are indeed mostly persons whose previous health has been remarkably good; but the vigour of its growth, as measured by the number and size of the deposits, generally increases instead of diminishing with the exhaustion of the patient. Many a person suffering from cancer comes under the care of a surgeon in a state of exhaustion, sleepless from pain, without appetite, and thoroughly ill. A few weeks of judicious general treatment and ample nourishment completely alter the state of the health. In the former condition the disease advanced, not only by sloughing and ulceration, but also by fresh cancerous deposition: in the latter state the processes of health predominate over the local disease; cicatrisation occurs, and the growth of the cancer is retarded, if not temporarily arrested. Improvement of the health does not feed, but starves, the disease; the reverse of what would happen if cancer were directly dependent for its vigour upon that of the system.

The results of statistical inquiry into the ages of cancer-patients confirm the conclusion which has just been stated. It appears that, with one exception, cancer bears a greater relative proportion to the number of persons living in the community as age advances. That exception is the period in which the generative functions cease. In that part of life the decline of activity in the female sexual organs is marked by a prevalence of cancer in those organs far exceeding that which is common to them at earlier or later periods of life. On the whole, therefore, it may be stated that vigour of life excludes cancer, the cessation of activity favours its occurrence.

The same remark is to some extent applicable to the life of the affected organ, as to that of the system in which cancer originates. The disease does not spring out of the vigour of the part. If vascularity only be considered as indicating vitality, cancer does not choose, or grow most in, the organ which is the best supplied with blood; the bones are at least as prone to cancer as the brain. And if vigour of life be measured by the elementary changes and activity of the organ, the stomach should be far more often cancerous than the skin; and pregnancy and lactation, instead of the intervals between those energetic functions, should be the occasions for cancer-growth in the breast and uterus. That cancer requires an ample supply of blood, needs not to be denied; but the amount supplied depends on the vascularity of the tumour itself, and is in no sense the determining cause of a cancer-growth. And that cancer originates in organs which are capable of great activity, and may indeed be essentially a misdirected outburst of it, needs equally not be denied; but it is their state of quietude, rather than of activity, which is associated with a growth of cancer.

Pregnancy and lactation afford the opportunity of observing the influence of functional activity and abeyance upon the occurrence of cancer in the uterus and female breast. As a general rule, the disease does not originate in those organs during the active performance of their functions. I am unable to recall to mind any instance of the first appearance of cancer in the uterus during pregnancy. Symptoms of the disease are not very uncommonly exhibited by that organ at or soon after the termination of pregnancy, but never, so far as I know, during it. Dr. West ascertained that in 8 out of 109 women the first symptoms of uterine cancer appeared immediately after parturition.* This fact has the same import as the observation, that the womb is most liable to cancer in the decade of life during which its function is ceasing, viz. from forty to fifty.

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* *Diseases of Women,* part i. p. 363.

The natural activity of the organ precludes cancer; the subsidence of its function favours the occurrence of that disease. The facts observed in the breast are not inconsistent with this conclusion, though they do not so plainly demonstrate it. There is the same excess in the liability to cancer of the breast from forty to fifty years of age, as is the case with the uterus; but it is not so manifest as in the uterus, that cancer makes its appearance in the former organ just at the time when its temporary function is subsiding. There are no observations which connect so large a proportion of cancers of the breast with the cessation of suckling, as of the uterus with the end of pregnancy. During the time of its functional activity, the mamma is very rarely if ever affected. I have once met with a case in which, during pregnancy, a scirrhous tumour was first observed in the breast, but never during lactation. Mr. Paget, however, mentions one instance of scirrhus being first noticed in the mamma during suckling: the patient was dead seven months afterwards.

The effect of the supervention of pregnancy or lactation upon cancer already existing in the appropriate organ is not uniform. The local activity and the increase of vascularity are sometimes accompanied by a rapid extension of the malignant disease. At other times the tumour appears unaltered by the local changes. As the observations on this subject are not numerous, I subjoin a brief account of the instances which have occurred to me.

A lady, aged thirty-six, was sent to town for the removal of her right breast. Two years before, she had been prevented by pain from suckling her last child with this breast, but it was only for eleven months that she had been conscious of the existence of a tumour in it. When I saw her, she was in the fourth month of her eighth pregnancy. In the first month of her being in that condition, the tumour had appeared to diminish under the use of iodine, but during the three later months a considerable increase had taken place in it. Finding an advanced and rapidly growing scirrhus in the breast, adherent to both the skin and the pectoral muscle, having a scabbed ulcer in one part, with numerous tubercles in the adjacent skin, and enlarged glands in the axilla, I was compelled, to the patient's surprise and distress, to decline operating.

A woman, aged thirty-one, became my patient in the Middlesex Hospital for cancer of the left breast. She was well nourished, but her neck was marked with the scars of abscesses, which she had had as a child, and her skin was very thin and fair. Twenty-one months before her death, she first noticed a tumour in the left breast. She became pregnant, and in the twelfth month after the discovery of the tumour was confined. During the whole of her pregnancy the tumour did not grow to be larger than a walnut, and in the early period of lactation it gave her little inconvenience; but by a sudden outburst of growth, in the fourth month of lactation, it reached a very great size, and did not cease its growing when her child, at six months old, was weaned. It had the character of an infiltration of the breast, being very prominent at one part, and thinning out towards the edge of the gland. Its surface was covered with alternate hard and soft nodules of breast-tissue; its substance was very hard, but neither skin nor pectoral adhered to it, and the nipple was not retracted. A part of the mammary tumour softened, but never broke; on both sides of the body the axillary, cervical, and inguinal glands became cancerous; similar nodules formed in the skin, and a second tumour in the right breast, and the patient died with dyspnœa and exhaustion three months after weaning her child.

A woman, aged thirty, was shown to me at the Middlesex Hospital by my colleague, Mr. Nunn. At the outer edge of her right breast was a scirrhous cancer of the size of a large walnut. The skin was adherent to it, and the absorbents and two glands of the axilla were perceptibly enlarged and hardened. She had first noticed the lump in the third month of her last (the ninth) pregnancy. She had been confined three months, and finding herself prevented by the pain of suckling from nursing the child, she had weaned it. She was under the impression that the tumour had lately diminished.

From these cases it appears that the activity of the uterus does not prevent the occurrence of cancer in the breast, or necessarily increase the vigour of the disease if it be already formed there. In two cases the mammary scirrhus grew slowly, or not at all, throughout the period of pregnancy; in the third case, therefore, it cannot be assumed that the rapid extension of the tumour was occasioned by the accident of pregnancy, and by the increased vascularity of the breast which was consequent upon that state. There is thus some difference in the liability of the breast and uterus to this disease. Cancer of the breast has its course and its interruptions independently of these occasional excitations of the reproductive organs; cancer in the uterus appears to be kept off by pregnancy.

The relation of cancer to foregone activity of the uterus is strikingly shown in the results of Mr. Sibley's statistical investigations already alluded to, and it accords with the conclusion stated with regard to the predisposing conditions of the disease. Neither virginity, barrenness, nor moderate fecundity favours the occurrence of cancer in that organ; the disease is most frequent in the most prolific. If the average number of children by each marriage be taken as four, the families of those women afterwards attacked by cancer of the uterus are found to be considerably in excess of that average, being 5·2. The circumstance is remarkable in relation to a similar observation of fecundity in phthisical mothers, as furnishing an additional chain to connect together the two diseases.

Little as cancer is influenced by the natural actions, it is almost as independent of most of the diseases of the body. The existence of Bright's disease of the kidney does not prevent the occurrence or alter the course of cancer; does not even prevent the withering and complete cicatrising of the primary disease. Opium-eating is no safeguard against it, no means of altering its progress. I removed the breast of a lady of forty-six during the present summer, in which a firm cancer had formed and rapidly grown, although she was in the habit of taking never less than nine grains of opium daily. Cancer may co-exist with extensive skin-disease, with syphilis, caries of the spine, and fatty and hobnailed liver. Exanthematous fevers are unknown in our cancer-wards, except, indeed, erysipelas, which is not less common in such patients than in others. The effect of erysipelas upon some cancers is very remarkable. I have seen every trace of the disease removed, as erysipelas swept over a cancerous ulcer, and perfectly healthy granulation and cicatrisation supervene. In a few days, or weeks at most, the original character of the ulcer reappeared. I have also seen precisely the same event happen from hospital gangrene. An ulcerated cancer thus attacked seemed to melt away in soft pulpy shreds, and with a most fœtid discharge. Soft and apparently healthy tissues remained, and granulation and cicatrisation took place. First at one edge, however, and in a month afterwards over the whole sore, the character of cancer reappeared. Certain diseases seem to be very rarely associated with cancer, if not to preclude it. I am acquainted with a whole family in which there is no record of an individual having died of cancer; but apoplexy and heart-disease have been almost the only causes of death for three generations. Mr. Sibley likewise remarks the rarity of organic affections of the heart amongst the numerous cancer-patients whom he examined after death in the Middlesex Hospital. Tubercle appears to be no less manifestly incompatible with cancer, while yet related to it. For albeit traces of old tuberculous disease are remarkably common in the bodies of persons dying of cancer, and in 34 per cent of them phthisis exists in the family, the two diseases are never found in active growth together in the same person. Such cases have been described, but they will not bear microscopic examination; the apparent tubercle is really cancer. When active tubercle does exist in the body of a cancer-patient, it has, as it were, supplanted the latter disease, which may wither and even cicatrise as the patient is rapidly dying of phthisis. With the exception of tubercle, perhaps the most common concurrent affection with cancer is some form of innocent tumour, though this is more obvious as an equivalent of cancer in other members of the patient's family than in himself.

The hereditary nature of cancer. Were there no tendency in the offspring of the unhealthy to return to the natural type of their race, the personal peculiarities in which parents deviate from that type would be strictly and always inherited. If, on the contrary, the characteristics of parents were not impressible on their offspring, no disease at all would be heritable. Cancer, like many other diseases, appears to be subject to both these rules. The propensity to the disease may be conveyed by a parent to his offspring, and its characters when exhibited by the latter may be little unlike that of the parent. But it may be, and commonly is, so much altered by the influence of the other parent or by inappreciable intercurrent conditions in the life of the offspring, that the disease eventually developed in the latter may be a different form of cancer, or may not be recognisable as cancer at all; the tendency fading out, as it were, in transmission into some kind of innocent tumour. Such facts as the following appear to prove the hereditary nature of cancer: 1. Some entire families are exempt from the disease. It has even been stated to be unknown amongst some of the aboriginal races of mankind; but such an assertion is very difficult to substantiate or to deny. I have made the inquiry of a medical man who lived in the bush in Australia, and he informed me that cancer was unknown amongst the native tribes of that country. 2. In other families it is known to have occurred in more than one individual. It was thus traced by Mr. Sibley, amongst the cancer-patients of the Middlesex Hospital, in one case of every nine; by Mr. Paget in one of every six cases. Such proportions are, of course, far from being a proof that cancer is a family disease; but it is sometimes so remarkably prevalent in one family that, in the absence of other explanation of its origin, and in concurrence with the fact of its being so often observed, hereditary derivation must be acknowledged. Mr. Arnott and Mr. De Morgan successively had charge of members of a family in which disease was thus exhibited. The father and his relatives were healthy. The mother died of cancer of the breast; two of her sisters of phthisis, and one of dropsy. Of six daughters, five had cancer of the breast, the youngest was still healthy, and the only son died of phthisis.

Treatment of cancer. This subject involves the consideration of the management of the general health and constitutional taint; the remedies suitable for the various states of the external disease; and the special question as to the propriety of extirpating the primary tumour, with the modes of accomplishing it.

General treatment of cancer. It needs hardly to be repeated that no remedy is at present known to have a specific power of eradicating the constitutional cause or taint of cancer, or of altering the nature of its growth. In our present ignorance of the causes from which the singular variations in this disease spring,—the sudden outbursts, the tardy progress, the withering, the local changes, and the general dissemination,—we are hardly in a position to estimate the actions of any remedies which we may employ. For the same reason it seems unprofitable to enumerate in this place the very many medicines which have been fruitlessly prescribed in cancer. A description of their effects may be found in our medical and surgical dictionaries and cyclopædias.

From the study of the influences which appear to control cancer, it is evident that the greatest benefit at present obtainable from medical treatment is that which is likely to arise from improving the general health. As that fails, the disease advances: with its improvement the cancer-growth is stayed. And the result of well devised hygienic and medicinal treatment is sometimes so striking, that, in combination with other suitable measures for the local management of the tumour, a considerable amelioration of the patient's condition and a prolongation of life may not rarely be looked for. Those methods of treatment which exhaust the bodily strength must accordingly be abandoned; the mind should be relieved as much as possible from sources of anxiety, and should be calmed and encouraged; nutritive food with suitable stimulants should be administered, and such medicinal remedies prescribed as appear best suited to exalt the constitutional powers. Arsenic with some practitioners, iodine with others, the vegetable tonics and bitters, alkalies and opiates, with others, find favour according as they effect this purpose of improving the general health of the patient. In common with many other surgeons, both of the present and the last century, I have found advantage to be derived from the use of iron; but it is more particularly when united with chlorine that it has appeared to me to be beneficial in cancer. This observation has led me to employ more commonly than any other remedies both iron, morphia, zinc, and potash in this combination. That chlorine is invariably useful I neither could nor need assert, since the conditions which make up general health vary too much in different persons to be all subject to one remedy, and it is not my wish to claim for chlorine, any more than for iron or other medicines, a specific control over constitutional cancer. It has, however, occurred to me not unfrequently to inquire whether the marked preference which secondary cancer exhibits for the liver, and the decided action of chlorine upon that organ, may not concur in some measure to explain the benefit which I have thought to be derived from the employment of small quantities of that remedy in cancer. Upon the administration of chlorine in the form of vapour-baths, as recommended by Mr. Wallace, or of nitro-muriatic acid baths, as successfully employed for other diseases by Sir Ranald Martin, I have not ventured, as being somewhat too exhausting a remedy in cancer. Amongst the medicines already mentioned, however, and by inhalation, it may be conveniently given. An apparatus which is in use for purifying and impregnating the air of sick-rooms with chlorine seems to be beneficial also by introducing the gas into the system. It is sold under the name of a "Chlorine Generator," and produces the gas out of a mixture of manganese, chloride of sodium, and sulphuric acid. The supply of chlorine can be regulated by this apparatus, so as not to exceed a quantity consistent with the comfortable respiration of the patient.

The *diet* of cancer-patients should be ample and nutritious. Whether nourishment should be supplied in the form of milk-diet, should include animal food, or be exclusively composed of vegetables, are questions still under examination. Those Surgeons who have prescribed only vegetables, or a milk-diet, have spoken highly of the effects in retarding the return of the disease after operation; but it must be observed that an extensive trial is necessary to establish any statement as a fact in respect to a disease so variable in its natural course as cancer, and that there is no evidence in the nature of the disease, or in the result of many prolonged cases in which the diet was not so restricted, to show that animal food is prejudicial. The plan of nearly starving a cancer-patient, with a view of delaying the return of his disease, has been just as highly spoken of. I have not tried this plan, or seen it tried, and am disposed to think that, as a disease possessing a great and exhaustive power of growth with a feeble vital stability, cancer rather necessitates an ample supply of nourishment for the subject of it.

Local treatment of cancer. Considerable skill is required in adapting the local applications to the varying conditions of the disease. In its occult stage it should be supported, not compressed, should be shielded from changes of temperature, and carefully guarded from injury. When not thus cared for, it is apt to be attacked with unusual pain, which indeed often follows the necessary manipulations of the surgeon in examining a cancerous tumour. A layer of cotton wool, fastened on with a kerchief or bandage, best fulfils all these indications: the further directions of the surgeon as to securing rest for the tumour vary with the organ or neighbourhood in which it is situated. Of medicated applications those should be avoided which excoriate the surface, and those which contain mercury; but the various other discutients may be used, and may, if desired, be combined with sedatives. Iodine, lead, and opium appear to be the most effective in reducing the adventitious swelling and retarding the growth of the tumour. A scruple of the iodide of lead suspended in a drachm of glycerine, and mixed with an ounce of unguentum opii, forms a convenient ointment. It should be gently rubbed over the swelling two or three times a day, and also left on it, in order to continually moisten the surface. A leathern or amadou plaster will be found a very convenient form of local application, as it may be retained on the part for two or three weeks at a time, and it withdraws the tumour for that interval from the close and anxious scrutiny of the patient. It may be spread with opium or other emplastra according to the indication of the moment; but it is by no means certain that the reduction in the size of a cancerous tumour, which is often observed to take place beneath a plaster, is not due to the gentle irritation of the skin which it causes, and the protection it affords, as much as to any medicinal properties of the drug which it happens to contain.

When sloughing of the tumour, or a portion of it, occurs, the appliances referred to in the article GANGRENE must be used. A bread poultice will commonly be found the most soothing application in the great pain which often attends this process, whilst the balsam of Peru or powdered charcoal, laid on beneath the poultice, corrects the offensive fœtor, and favours the separation of the slough. The painful, precipitous, and rugged ulcers, which form in the centre of a mass of cancer, are often most easy, and kept most free from offensive odour by a weak solution of the chloride of zinc in the sedative solution of opium. They should be often washed out with a stream of tepid water having in solution a little chlorate of potash. Lotions of conium and opium, and of the diacetate of lead in combination with one or both of these vegetable sedatives, may also be alternately employed. It is worth observing, that a solution of powdered opium itself sometimes affords more effectual relief in such cases than any of the preparations which are made from it.

For open cancers presenting little activity on their free surface, sores which are less excavated by ulceration than tuberous from the outgrowing of the subjacent cancer-material, and which appear as ordinary carcinomatous masses merely uncovered by skin, cotton-wool is sometimes treatment enough, there being no indication but that of supplying a kind of cleanly sponge to receive the thin discharge which oozes forth. The oxide of zinc, the trisnitrate of bismuth, and similar innocuous substances may be applied in the form of powder or of ointment; and they are sometimes spoken of by the patient as grateful and soothing to the part.

The œdema of a limb, produced by cancer in some higher part, is often a very troublesome symptom to the patient. It should be treated by occasional fomentations and by the cautious application of a current of steam. In the intervals of such treatment the greatest relief will be afforded by soft bandages; by firmly swathing the limb, for instance, in a flannel roller. The pain in the arm complained of by patients suffering from cancer of the axillary glands is often too great to be accounted for by the œdematous tension of the limb, and is probably due to the invasion of the principal nerves by the growth. In the lower extremity, where the inguinal glands are superficial and the nerves are deeply seated, the œdema which results from the cancerous infiltration of the former is often a far less painful symptom than in the arm.

As the disease advances, the sufferer should be prepared to see without alarm moderate hæmorrhages from the surface as it is dressed, and may be supplied with a fresh infusion of matico, or with a solution of the perchloride of iron, to arrest them. If ulceration spread into the neighbourhood of large vessels, the surgeon must himself be on his guard, and should make the patient aware of the possible occurrence of a hæmorrhage, which, under such circumstances, may be rapidly fatal. (See HÆMORRHAGE.)

The *treatment adapted for the primary tumour* in cases of cancer is a question of great moment and difficulty, and divides the opinions of surgeons. Practitioners who are sufficiently agreed in respect to the constitutional treatment, who agree also in acknowledging that there are cases which resist all remedies, and for which no plan of treatment is to be held answerable, who are further at one in regarding cancer as capable, on the whole, of being modified in its course and severity, of being lengthened out in its duration and lessened in respect to suffering, by treatment, differ totally in regard to the management of the primary tumour.

The question relates to the propriety or impropriety of removing the tumour. In respect to an innocent growth, the right proceeding is sufficiently plain. If the system be healthy, the tumour growing or inconvenient, and the circumstances of season, air, and place suitable, an innocent tumour may be safely and finally extirpated. But when the tumour is malignant, excision in the very large majority of cases is not a final remedy. The disease returns in the unhealed wound, or in the scar, or in the glands; or, should those parts remain healthy, the internal organs and distant structures of the body become cancerous, and sooner or later, after all, the disease is fatal. As, moreover, some few persons actually die of the operation, great mortification and regret are naturally excited by its failure, and the propriety of repeating it in other cases is denied. Measures are adopted as alternatives of the operation, which are believed to be calculated to repress the growth of the disease, but by practitioners of this opinion the primary tumour, with whatever power of spreading infection it may possess, is left attached to the body. Notwithstanding occasional most painful failures, the following considerations appear to me to establish the propriety of extirpating the primary tumour in certain cases.

In the foregoing pages I have represented a disease which varies greatly in its course and malignant character. It is, therefore, plainly impossible to lay down one rule of treatment which shall apply to all cases. And the capricious and uncertain nature of the disease renders it difficult to ascribe the changes in its course to treatment or the omission of treatment. Only by a large number of facts can the influence of any mode of treatment be ascertained. This influence has to a considerable extent been established in respect to the removal of primary cancer. As the operation in cancer is most frequently performed on scirrhus of the female breast, the following remarks may be considered to apply especially to it, unless distinct reference to other cases be made.

The grounds on which an operation in cancer may be performed should be distinctly understood. They are, 1st, the hope of entirely and finally eradicating the disease; 2d, that of obtaining some interval of health and useful life in its course; 3d, that of, on the whole, lengthening life; 4th, that of diminishing the total amount of suffering.

1. The first of these reasons may sometimes, but rarely, sway the mind of surgeon or patient in deciding upon an operation. The evidence of thoroughly competent surgeons is to the effect that unquestionable cancer of the breast, and less rarely of the lip, has been removed by operation, and through a life of many years has never reappeared. Practically, however, on account of its rarity, this consideration can have but little influence in the decision of the question.

2. The hope of temporarily renewing the health and usefulness of the patient is the chief, though not the only, ground for recommending an operation. Regarded by itself, it cannot but be esteemed as a very great benefit, and from the point of view of the patient may seem and be of infinite importance. What the duration of that interval may be is commonly too uncertain to be predicted, except in cases which ought not to be operated on at all. Upon an average of properly selected cases, it may be said to extend to about twenty-four months; the majority of patients being laid up by a recurrence of the disease in the first year, whilst some remain free from it for a considerably longer period.

The longest intervals which elapse between the time of extirpating a scirrhous breast and the recurrence of the disease occur in cases in which the operation is performed within a few weeks after the discovery of the disease. Ten or twelve, even fifteen, years of health have sometimes intervened, when patient and surgeon have both been thus prompt to detect the nature of the tumour and to decide upon its removal. That in all instances equal promptitude has not been so largely rewarded may have been due to the form of the disease, or to the unhealthy circumstances in which the patient happened to be placed subsequently to the operation.

3. To assert that in any individual case life is lengthened by the operation is rarely possible, since we are necessarily ignorant of what would have been the duration of life if the disease had been left to run its course; but it may be assumed to be lengthened when the early effect of removing the primary disease is a return of both a feeling and an appearance of general health which did not exist before the operation. The only other mode of determining the influence of an operation upon the duration of life is that of contrasting the average duration of life with and without it. No observations exist by which this contrast could be fairly drawn. On the one hand, the majority of the cases selected for operation are such as present the least probability of early death; these

give too favourable a view of the operation: on the other hand, the speedy mortality of the operation itself, though rightly enough to be set in the balance against the performance of it, yet occasionally vitiates the observation of its effect upon the progress of the disease. With these restrictions, which, however, in some degree compensate one another, the result of the operation, as observed in the Middlesex Hospital, may be stated to be favourable to its performance. It lengthens life in some cases which were hastening to a fatal issue, and can rarely be accused of really shortening it. The average duration of life in seventy-eight cases of breast-cancer not operated on was 32·25 months, while in fifty-seven patients from whom the primary tumour was removed the disease was not fatal in less than 53·2 months. Sixty operations were done on these fifty-seven patients, and the average includes three deaths which resulted from the operation.*

The proportion of deaths resulting from operations in cancer being less at the Middlesex Hospital than is† supposed to be usual, it is right to say that this result may, in a great degree, be due to the healthy situation of the Hospital, and the excellent system of ventilation which the wise liberality of the Governors has secured in it. In the selection and preparing of the cases for operation no precautions probably are adopted which any educated surgeon would neglect to observe. A strict investigation is made into the general health of the patient, into the state of the liver, and especially of the kidney. The urine is tested, and no operation performed if it is found to be albuminous. Some brief delay is usually allowed between the admission of the patient and the time of operation, for the investigation of these matters, for the occurrence of the catamenia in women, and for regulating and improving the health. The evacuation of the bowels is secured on the morning of the operation, and the patient is supported after it by suitable stimulants. It is my own practice to allow port-wine from the very commencement of the after-treatment. The practice of leaving the wound open for some hours after the operation is adopted, and it is found that the suffering attendant on secondary hæmorrhage, and the dangers incident to the accumulation of clots in the wound, are thereby much prevented.

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* Sibley, loc. cit. pp. 123, 126.

† The mortality of the operation of removing the mamma is generally stated at 10 per cent, and is so given by Mr. Paget in vol. ii. of his *Surgical Pathology*, p. 351. The average of deaths in sixty operations, performed on fifty-seven women in the Middlesex Hospital, was 5 per cent.

4. The argument in favour of an operation which is looked for in the resulting diminution of suffering is as difficult to substantiate as that drawn from the increased duration of life. That in some instances the operation *appears* to excite the local disease to a degree of activity which it did not previously exhibit, cannot be denied; but neither can it be questioned that the suffering after an operation is often far less than it could have been without one. The disease is transferred to other parts, and the patient is spared the distressing consequences of sloughing, ulcer, and discharge which arise from the external situation of the disease. It is no slight alleviation of the total suffering to be relieved of one, and commonly the worst, of the tumours. But further, in ordinary cases in which the disease returns *in loco* after an interval of time, the suffering is no greater than it might have been if the tumour had been left to itself. There are cases of pain as great, and growth as exuberant, when the disease has pursued its natural course, without surgical interruption, as when it recurs after operation. At the post-mortem examination of a case of cancer of the breast, it is often impossible to predicate whether there has or has not been an operation in the course of the disease. The appearances on the chest are alike, and there is no appreciable difference in the mode or extent of the cancerous depositions within the body. It seems clear, therefore, on the whole, that the patient who escapes the recurrence in the external part is greatly better for the extirpation of the primary disease, while he in whom it returns has had his interval of health, and is eventually no worse for the operation.

Upon the four grounds just stated, the great majority of cases of cancer are not adapted for operation. Certain conditions of the patient or of the disease suffice to preclude it. Those of the patient are such as would interfere with any operation. No operation should be performed if there be reason to suspect a deposition of cancer in an internal organ; if there be albuminuria, or indication of organic disease, or of a state of the constitution which would render any operation improper. A permanent increase in the rapidity of the pulse, which cannot be accounted for by manifest activity of growth or by degeneration in the tumour, or as a family peculiarity, is a strong proof that the disease is already constitutional, and weighs much against operating, except for the comfort of the patient. The unfavourable states of the disease must be described more at large.

1. A diffused scirrhus, one which widely infiltrates the breast-tissue, must not be operated on. The knife could only be carried

through diseased textures, and the wound could not possibly heal. Œdema, which does not disappear during rest and under suitable treatment, is decisive against an operation.

2. The existence of cancerous tubercles in the skin over a mammary tumour is a sufficient reason for avoiding an operation. That contamination of the skin with cancer which is shown by its increased thickness, its wide adhesion over the tumour, the enlargement of its pores, and the difficulty of pinching it up, as can be done with the soft loose skin of the opposite mamma, is decisive against the operation. Though the incisions were made in healthy structures, outside all the thickened part, and though the wound might heal, yet the disease would rather speedily return in and near the scar.

3. When the glands are diseased to an extent too great for them to be removed, when *e. g.* those above the clavicle are enlarged, the primary cancer must be too widely spread for even temporary relief from the removal of it.

4. An adhesion of the tumour to the pectoral muscle weighs much against the operation, but if the disease be small and deeply seated, does not forbid it.

5. Rapid growth and medullary nature offer hope of benefit from the operation only if the latter be early performed, and in clearly healthy parts.

6. No case should be operated on if there be more than one tumour in the body. The coexistence of cancers of both breasts, for instance, or in two limbs, though both removable, renders an operation on one or on both improper.

7. Cancers beneath the scalp should not be interfered with; they are rarely or never single, and they often extend through the skull. Those which spring from the bones of the face, and protrude into its cavities, are but rarely adapted for operation. In their early stages they will and may be removed in the hope of their proving to be of innocent nature; but in their advance toward the surface, where they become clearly recognisable, they often lose the character which alone permits of their being extirpated, namely, that their boundaries be plainly limited. Tumours of this nature which widely expand the ethmoid cells, or the maxillary sinus, which raise the nasal bones, or which cause swelling above the zygoma or behind the ramus of the jaw, as well as those which are connected with the base of the skull, should not be touched. Cancers of the eye may be operated on in early stages of the disease, while still limited within the globe. Scirrhus in that organ is slow in return-

ing after an operation, and is asserted by Mackenzie, who described it, sometimes not to recur. If the disease be of the medullary or melanotic form, it is only in very early cases that benefit from operation can be looked for. The disease involves the optic nerve at an early period, if it do not even sometimes originate there. When the eye becomes fixed in the orbit, or the tumour has passed beyond the globe, the surrounding tissues will have already become unfit for the requisite incisions. (See EYE, EXCISION OF.) Large soft cancers in the neck can rarely be removed. Their appearance of mobility is often deceptive, and they may possess intimate adhesions to the vertebræ and other deep structures. Comparatively little benefit, probably, attends operations for cancer in young subjects.

The following cases may be selected for operation, with the hope of benefit.

1. When the disease is a single tumour, clearly distinguishable, not diffused, and whether in the nipple, on the surface, or in the substance of the breast.

2. When the nipple alone, or some portion of skin, is drawn in towards the subjacent tumour. In either case, the superficial part not being widely infected but simply dimpled, the breast may be removed.

3. The ulceration of a cancerous tumour does not preclude the operation, if in other respects the case be fitted for it.

4. If the glands be diseased to an extent which does not interfere with their removal, the primary disease may be extirpated. It is my own practice to remove the glands, inasmuch as the disease, when established in them, is as independent and as capable of multiplication as an equal quantity of the original tumour; and it is advisable always to examine them, even when apparently healthy, since they are not unfrequently upon exposure found to be cancerous.

5. A limb may be amputated for cancer, although the glands show some hardening or doubtful enlargement. This rule applies both to the medullary and epithelial disease. No advantage beyond altering the site of the disease will commonly be gained by an operation in instances in which the absorbents are already much or chiefly affected; and that is not sufficient to warrant its performance. The pain attending the later stages of the disease in the testis renders it advisable to castrate, so long as the cord is healthy in the part to be divided.

6. It might be supposed that a marked hereditary tendency

would render cancer rapidly fatal, and entirely preclude any operation. Yet in the family already referred to, of which six members were the subjects of the disease, one sister suffered amputation of the breast on account of it in 1845, and another in 1846. Both patients remained well, until in each of them a recent recurrence of the disease rendered necessary a repetition of the operation in 1856. Both also were alive in 1859. It is worthy of remark, that the breast was removed from one of these sisters by Mr. Arnott, in a month after the first discovery of the scirrhus, and when it was no larger than the end of the thumb.

7. A recurrent cancer may be removed under the same restrictions as apply to a first operation. But in most instances it may be better treated by caustics or compression; either of which methods is more in place in the management of recurrent cancers, and of those which cannot be extirpated with the knife, than in the treatment of the primary and removable tumours. The plans recommended for occult and ulcerated scirrhus may also be found suitable in similar states of the recurrent disease, the intervening operation making no difference in this respect.

8. Under circumstances of age, or such mere infirmity as will not render the operation fatal, it may sometimes be right to remove an active cancer, which is inevitably mortal; when an innocent tumour, being a mere inconvenience, would be left to die with the patient. Every such case must be decided on its own grounds, according to the judgment of the surgeon and the choice of the patient.

In the performance of a cutting operation for cancer, much depends upon the thorough extirpation of the disease; and it is generally advisable not only to cut wide of the tumour, but with it to remove the whole organ or part in which it is seated, such as breast, eye, testis, scar, bone. Very small portions, especially of the first-mentioned organs, when left at an operation, appear to become the seat of a fresh growth of the disease. In limbs, as a general rule, amputation is preferable to a local, which is often necessarily a partial, extirpation.

The operation should be done at the earliest possible period. All delay is to be avoided, except that which may be required for the improvement of the general state of the patient. There are surgeons who reserve the operation almost only for those few and rare cases in which the disease long remains a local affection, and becomes a source of much suffering only in its later stages. There are others who, concurring in the propriety of an operation at some time, but observing the temporary cessation of growth which usually intervenes between the first outburst and final ulceration of the primary growth, recommend that the operation should be postponed until the tumour is quiet. But if it be a just view of cancer, that from the primary tumour there is constantly emanating a material something, by means of which the contamination of the rest of the frame is chiefly effected, the principle must in that point of view be erroneous which leaves such a tumour connected with the frame. No proof yet given is sufficient to show that any means but extirpation can be trusted to prevent that mischief.

Again; the practice of leaving the primary tumour, in the hope of removing it with better effect at a later period of the disease, is virtually, in the great majority of cases, a final decision against the operation. Adhesions take place, the cancer spreads far, and the opportunity of removing it never arrives.

To adopt the principle of delay is to ignore those facts already mentioned, which show how long-continued may be a patient's freedom from the disease, if it be early removed.

Such considerations deter me at present from ever adopting the plan of compression, or any other method of treatment by which the extirpation of the primary tumour, when feasible, is delayed. There are, and must continue to be, objections to the operation; but to these all other measures which have been suggested for the treatment of cancer are also liable. To that of exasperating the disease I cannot think it exposed, when I consider its natural proneness to sudden outbreaks independently of all treatment, the instances in which an operation has appeared to me to make no difference in its progress, and the fact that I have never known such an increase in the rapidity and amount of the cancer-growth as is contemplated in the accusation, except when an operation has been abandoned, and the deepest part of the growth has been left. To another accusation it undoubtedly is more fairly exposed. The supposition that the cancer is capable of being effectually removed is too frequently an error which is only discovered at or after the operation. It appears to me that the whole cancer is, in fact, less frequently eradicated than is sometimes supposed. I do not allude by this remark to such a case as I have seen, in which the operator made his incisions through tissues which were crisp and brittle with cancerous infiltration. I allude to instances in which, although all the disease appeared to be removed, in which also I have myself been the operator, yet within a year afterwards a number of small cancerous nodules, appearing in the subcutaneous tissues and in the pectoral muscle, showed that imperceptible fragments had after all not been extirpated.

Such cases manifest the need which exists for the greatest circumspection in selecting cases for operation, not the impropriety of ever performing it.

The operation in cancer is wrongly appreciated if it be supposed to supersede those general measures upon which the subsequent maintenance of the health of the patient depends. As in other constitutional diseases, the failure of the health is eminently likely to prove the occasion for the recurrence of the disease. Attempts have been often made to retard that event by prolonging as much as possible the healing of the wound of the operation. No particular advantage has resulted from the procedure, which appears likely rather to invite than to ward off the dreaded return of the disease. A greater good may be asserted to have attended the establishment of a slight drain from some part of the surface, which is near enough to influence the locality of the disease without being itself very liable to taint. The existing evidence appears sufficient to warrant the insertion of a seton beneath the shoulder, after the patient has recovered from the effects of the operation of removing a scirrhous mamma.

Treatment by caustics. By means of caustics efficiently used, it is possible to destroy the vitality of a whole tumour, and obtain its complete removal; but the severity and long continuance of the pain ordinarily occasioned by them forbid their employment when chloroform and the knife are not contra-indicated. Caustics exert no specially curative action upon cancer-structures, but they present two advantages over a cutting operation. Their employment is not attended by an effusion of blood, and the consequent exhaustion; nor, in some seventy cases in which I have seen caustics applied, was their use followed by erysipelas or pyæmia. And, further, in most cases they occasion a considerable emaciation of the healthy tissues adjoining the slough, and a diminution in the size of glands secondarily affected with cancer. Amongst many patients, treated in the Middlesex Hospital with caustic in the summer of 1857, there was a marked difference in the effects. In some it appeared to act in the same manner as erysipelas and hospital gangrene. Apparently, but in fact incompletely, removed, the disease reappeared in a few weeks; in those cases, however, in which caustics were carried through the cancer into healthy tissues, no such recurrence took place before the healing of the wound. After that event, the cases treated by caustic followed the ordinary course of cancer. Disease reappeared, and death ensued as usual. One of the patients was met with in July 1860, three years after the extirpation of the breast. The scar remained perfectly healthy. Some cancerous enlargement of a gland in the axilla and of another above the clavicle could be distinguished; but the patient was hardly aware of their existence, and her general appearance and feeling were still those of health.

None of these results of the use of caustics differ materially from those which attend a cutting operation, and in cases which are equally adapted for either no British surgeons resort to caustics. There are some instances of advanced and ulcerated cancer, however, attended with suffering, but having adhesions which could not be detached with the knife; and in these a gradual insertion of caustic is sometimes followed by the complete enucleation of the tumour and cicatrisation of the wound. The cases are few in which this treatment can be adopted, but the comfort and prolongation of life resulting from it reconcile the patient to the temporary pain by which those advantages are gained.

If, on such grounds as the less probability of a fatal result from the mode of proceeding, it be determined to treat a primary cancer with caustics, the general rules must be observed which are applicable to the selection of cases for a cutting operation. The cancer must be primary, solitary, and uncomplicated with evident constitutional disease or infection of the parts around it. Should the absorbent glands be affected, the operation by the knife is decidedly preferable to that by caustics, as it is difficult to remove glands by the latter method.

There are various methods of introducing caustics into a cancerous tumour. If a liquid caustic be chosen, its application must be limited by some contrivance; as, for example, a hoop or cylindrical tube of gutta-percha, set on its edge around the tumour, and closely glued to the skin by means of a solution of the same material in chloroform. The caustic liquid, poured into the cup thus formed, or laid in it as a paste made with saffron or sawdust, will then burn through the diseased mass, the depth of its action being determined beforehand by the quantity of the caustic employed. The strong sulphuric acid and the fuming nitric acid produce a dry, hard, and much-contracted eschar, which separates spontaneously in the course of from one to four weeks, and leaves a granulating and cicatrising sore.

Chloride of zinc may be made into a cake or a paste with flour, or may be employed alone. It can only be used upon a denuded surface. If the skin is entire, it must be first blistered or washed with the concentrated nitric or sulphuric acid. The chloride may then be laid over the tumour and allowed to penetrate through it. When the cancer is already ulcerated, the paste may be soaked through cotton-wool and introduced into the ulcer. The caustic, infiltrating the tissues, coagulates their albumen and blood, and produces a slough, which is moist as compared with that resulting from the acids, but which separates in the same manner.

When white arsenic was employed, it was mixed with calomel, or bichloride of mercury, or merely with flour, and laid in very small quantity upon a raw surface over the cancer. Like the chloride of zinc, it is inert if applied to the skin. A very small quantity, not more than two or three grains of this caustic, was used at a time; but as it became absorbed, and some patients died in consequence, the use of it has been abandoned.

A convenient plan for extirpating a cancerous tumour, and one which keeps the action of the caustic within the control of the surgeon, is to lay the paste of the chloride of zinc within a cancerous ulcer, or on skin previously destroyed by a strong acid, in the manner already described, and, through incisions deepened daily as the slough extends, to introduce fresh quantities of the same caustic, until the whole tumour is perforated and destroyed. It is then cast off, and a healing wound occupies its place. The process is a slow one, and portions of the tumour are apt to be left behind and to require a renewal of the treatment. It is also sometimes incapable of overtaking the progress of a very rapidly growing cancer. But it is ordinarily much less painful than any other procedure, and is applicable in some cases in which a tumour is so situated that the knife could not be used. This method of treatment, which was introduced into England by Dr. Fell, of the United States, was described at length, and an estimate of its surgical value offered, in a *Report on the Treatment of Cancer in the Middlesex Hospital in* 1857. In making the flour-paste, it is desirable to use a saturated solution of the chloride of zinc. I have sometimes employed water for this purpose, and sometimes, with the view of mixing with the caustic a powerful local sedative, the watery solution of opium.

Other modes of employing caustics may be suggested by particular opinions as to the best way of using them, or by the circumstances of the tumour. Caustics may be passed beneath a tumour in tracks made by a knife or a long seton-needle, and sufficiently near together to insure the death of the whole. The tracks may be parallel or concentric, and in the latter case need not pass completely across the base. With the exception of burning by the concentrated mineral acids, this appears to be the most rapid mode of causing mortification of a tumour. The hypodermic injection apparatus may be used for the purpose of injecting into cancerous tumours caustics in a liquid form; the saturated watery solution of the perchloride of iron appears to be one of the most effective and convenient substances which can be thus employed. It must, however, be cautiously used, as the action of a few drops may destroy an inch or two of tissue, and the inflammation and swelling around the hard and contracted slough are apt to be painful and severe.

Treatment by congelation. Dr. James Arnott has recently given much attention to the subject of destroying cancerous tumours by the prolonged application of intense cold. A cup of gutta-percha, moulded to the surface around the tumour, and provided at its lowest part with a tube to drain off the melted liquid, is filled with ice. As soon as the surface of the tumour is chilled by this application, a mixture of ice, salt, nitrate of potass, and hydrochlorate of ammonia, which is capable of reducing temperature to a much lower degree, is substituted for the ice, and renewed as it melts during several hours. The result is a complete death of so much of the tumour as is reached by the cold. In a case thus treated for several hours by Dr. Arnott in the Middlesex Hospital, at the request of Mr. De Morgan, the tumour was found by incision to be quite dead to the depth of an inch. The patient described the treatment as causing no pain, and she ate her dinner during its continuance with apparent unconcern. No ill consequences ensued; but it was found impossible to affect the tumour by the cold more deeply than has been stated, and it became necessary to remove its deeper portion with caustic. Subsequent attempts to freeze cancers were less successful than this, which had been conducted by Dr. Arnott himself; and it was evident that the procedure, though the least painful of those which cannot be carried out under chloroform, was not yet made efficient, and is far too difficult of management to be generally available. Congelation may be employed with great advantage in conjunction with caustic, of which it diminishes the pain without interfering with its action.

Treatment by pressure. The allegations which have been made as to the result of the treatment of cancer by means of compression have brought it into an unfavourable repute. Surgeons refuse credit to statements such as that of Récamier, that 30 per cent of his cases were cured by it. That it is a method of treatment which is often valuable, cannot, however, be denied, whilst the strong opinions of Dr. Walshe, and other practical men who have largely used it, remain unqualified. Compression, according to those authors, greatly retards the growth of cancer, destroys adhesions, lessens enlarged glands, and sometimes entirely dissipates a tumour which is indistinguishable from scirrhus. Its value as a means of controlling pain was allowed by the surgical staff of the Middlesex Hospital, who systematically examined it, and reported on the whole unfavourably upon it. The method is certainly far from being always successful in repressing growth; adhesions sometimes form during the treatment, and the disease may on the whole advance. Moreover, although in theory there may seem some probability that the dispersed fluids of a tumour thus treated will not become circulating germs, from which cancer may grow elsewhere, yet the supposition is not confirmed. No known facts respecting cancer justify the opinion that any of its material is capable of elimination from the system. For recurrent cancers, though slightly ulcerated, compression is an advisable method of treatment. It may be conveniently made, according to the plan of Dr. Neil Arnott, by means of a spring-truss, adapted in shape and size to the body or part to be compressed, and furnished with a concave metallic plate, with which to cover the tumour. Interposed between the latter and the metallic plate, a caoutchouc bag, partly filled with air, or a bladder containing a thin paste of oil and linseed-meal, forms the actual medium of compression; and its application is more defined and its pressure more steady and direct, if it be encircled with a canvas hoop attached to the rim of the plate. The continuous application of such a pad can be borne for many hours if the pressure be light, not more than 2 lbs. at first, and afterwards gradually increased.

Treatment by ligature. In certain situations it is sometimes convenient to employ the ligature in removing cancerous tumours, or even portions of a tumour. The circumstances suited for the adoption of this plan are detailed in the article Ecraseur (Surgical Apparatus); and in those on the diseases of special organs, as Penis, Tongue. The écraseur or the ligature may also be used to detach projecting portions of cancerous tumours, which by their mere position occasion inordinate distress to a weak patient. Large cancers of the upper jaw sometimes thus protrude into the mouth, and the removal of even a portion of them is a source of great, though temporary, relief to the patient, enabling him to close the jaw and to move the tongue more freely than before.

CHARLES H. MOORE.

CONTUSIONS.

CONTUSIONS are the injuries, other than wounds and fractures, which are produced by blows or sudden pressures. The term may, as a surgical title, include all such injuries, in their widest degrees of difference, from a simple bruise to an utter crushing of a part. The typical, being the most frequent, instance is the common 'bruise' of skin and subcutaneous tissue.

The states of parts recently contused may be studied in (1) their proper textures; (2) their blood-vessels and blood.

1. In the slighter degrees of contusion the textures suffer only a concussion, shaking, or jarring; a disturbance which may leave no visible change, except the effect of the rupture of blood-vessels. Thus it is in ordinary slight bruises.

In severe contusions the damaged structures are broken; there may be visible ruptures of muscles, blood-vessels, and other soft parts; splittings of the connective tissue between adjacent structures; and, especially, splittings of the subcutaneous tissue, and separations of it from the fasciæ, or other parts beneath it. These last-named injuries are, perhaps, the most common of those produced by heavy blows, and are those to which the chief external signs of severe contusions are due.

In the extreme degrees of contusion, the parts are thoroughly crushed. In a part thus damaged, the muscles and other soft parts may be so broken and crushed that, with the extravasated blood, they make a mere pulp; and such parts as hold-out and look entire, among which the skin, nerves, and tendons are most often found, are yet damaged beyond recovery, and perish in the gangrene which is the usual result of these extreme injuries. In crushings such as these, even the elemental structures of parts may be broken, and minute fragments of muscular fibres are easy to find among the materials of the pulp.

2. The injury done to blood-vessels in contusions is very difficult to ascertain. Sometimes ruptures of vessels are visible, but more often the extravasation of blood is the only evidence of the existence or extent of such rupture. And this evidence is not

exact; for, with the blood, there is more or less of blood-stained fluid, the diffusion of which makes the extravasation appear greater than it is.

Other things being equal, the quantity of blood extravasated would depend on the size and number of the ruptured blood-vessels. But many things make the quantity vary. The more lax the textures of or adjoining the injured part, the more copious the extravasation; witness the bruises on the eyelids, scrotum, and labia. The constitution of the patient has much influence. In scurvy, and the so-called hæmorrhagic diathesis, even slight blows may produce serious extravasations of blood; and many persons, especially pallid, fatty, soft-skinned women, though suffering with no evident disease, are subject to extravasations very disproportionate to the injuries that cause them. As they say, "the least touch bruises them."

The escape of blood in a contused part may cease in a minute, or less; or it may continue for two or more days, although there may be no reason to believe that a large blood-vessel is ruptured. Thus in children, a blow on the head may be followed by a swelling from extravasation, which will slowly extend over the whole forehead, or vertex; and a crushed leg or thigh may continually swell at the injured part, and become more and more tense with subcutaneous and intermuscular extravasation.

The blood extravasated is of dark venous colour; or, rather, becomes so while stagnant in the tissues: but it may be brightened in parts permitting the penetration of air, as in bruises of the conjunctiva, which are usually scarlet or bright crimson. The blood is commonly infiltrated among the structures of the injured part; or, many small clots may be scattered among them, with infiltration of blood and blood-stained serous fluid; or, nearly all that is extravasated may be collected in one or more large clots; or, more rarely, may remain liquid in a cavity left by the separated tissues. The causes of these differences are unknown; the consequences will be considered hereafter.

The signs of recent contusions, which are most general and characteristic, are, some degree of shock, pain, swelling, and ecchymosis.

The shock has in it nothing peculiar to this kind of injuries. Generally, and without referring to injuries of internal organs, it is proportionate to the amount of damage sustained. Complete crushings of small parts of the body, as part of a hand, or foot, are usually attended with less shock than are less severe injuries of larger extent. Contusions of certain parts, moreover, as the testicles, the large joints, and the breasts, are often followed by remarkable feebleness of pulse, sensations of sinking, tendency to syncope and to vomiting, and great temporary loss of muscular power.

The first morbid sensation, after that which is felt at the blow, is, usually, a numbness of the injured part; and the severer the hurt, the longer this may continue. But, unless the part is killed, numbness gives place to pain, which is commonly described as of a dead, heavy, aching kind. In the muscles, the pain is attended with more or less loss of power, and is greatly increased when they are made to contract; in the nerves, it is attended with tingling, or sensations of burning, both at the place of injury and in their distribution; in the testicles and other parts above mentioned, the pain seems to be a chief cause of the more intense shock that accompanies their contusions. When only the softer structures are contused, the pain is not usually associated with much tenderness, it may even be alleviated by pressure and friction; but the contrary is more frequent in bruises involving periosteum and other fibrous structures, and those of joints. In these parts, also, the pain and tenderness are, usually, of much longer duration.

Swelling, generally, follows quickly the violence by which a part is contused. First, some depression or indentation may be seen, with softening of the injured tissues; but, by their elasticity, they soon recover from this state, and then are raised with more or less of swelling. One of the best examples of this swelling is the bump that so quickly follows a blow on a child's head. It is due partly to extravasation of blood, but much more, in ordinary cases, to the rapid afflux of blood, and exudation of fluid from the vessels, in the stricken part. A similar swelling from contusion, but often attended with little or no extravasation, is in the wheal that rises after a lash with a whip. In loose-textured parts, as the eyelids, this swelling is often considerable, and may remain for a week, or more; in other parts it usually subsides in two or three days, or less; and if later swelling ensue, it is probably due to inflammation of the injured part.

Ecchymosis, when the consequence of blows or crushings of parts, is due to their being infiltrated with blood or blood-stained fluid, of which the colour is seen through the cuticle. The blood-stained fluid cannot be collected from the tissues in which it is infiltrated: but when they can be dissected, it is seen tinging them; and it is probably the same kind of fluid as that which fills the vesicles and bullæ so often seen in the neighbourhood of fractures (especially those of the tibia and ulna), attended with much contusion of soft parts. It appears to be serum, with suspended blood-cells, and dissolved colouring-matter; and according to the proportions in which these are present, so is its tint more or less deep, and like to that of venous blood. Where very small quantities of colouring-matter are present, and the fluid is collected in widely separated spaces of loose connective tissue, it may remain like the contents of a cyst. Such cases are sometimes described as 'traumatic hydroceles,' a name which would be not less ill-applied to the large vesicles over seats of fracture.

The colours of ordinary recent ecchymosis from blows are various shades of purple, tending on the one hand to black or blue, on the other to crimson or pink. Blackness, usually indicating intense injury, is probably due to the extravasation of a large proportion of entire blood; crimson or pink tints to the prevalence of blood-stained fluid; blue to the degrees in which blackness is veiled by the cuticle and skin, as the colour of blood in veins is; and, perhaps, some of the shades of pink to the partial aeration of the blood, by the penetration of air through the epidermis.

After a variable time, proportionate to the severity of the injury, these colours fade-out, passing most commonly through gradually lightening shades of brownish-olive, green, and yellow.

The changes usually commence at the borders of the ecchymosis, and thence proceed to its centre, but with so little uniformity that the commonest appearance of a fading bruise is motley.

The very changes on which these varieties of colour depend are not known. They are not generally, if ever, observed in bruises of parts removed from air and light. In a limb with ecchymoses of all shades at its surface, those in the muscles, periosteum, and other deep-seated tissues, are either black, or crimson, or of some of those pinkish or yellowish tinges, through which blood-clots in vessels pass in their gradual decoloration; they are not blue, or olive-coloured, or green. And in the ecchymosis of the conjunctiva, the scarlet of which contrasts strongly with the "black-eye" in the eyelids, the fading tint is usually only yellow.

The time at which an ecchymosis becomes externally visible after injury varies with the depth of the effusion of the blood. If it be at the surface of the skin, the ecchymosis may be almost instantly visible, or may become so in a few minutes. In deeper injuries, days may elapse, and the ecchymosis may then appear at some distance from the injury, and not directly over it, as it more commonly does; and may, from its first appearance, have the colours that belong to such as are fading. In like manner, as if with gradual diffuse infiltration of coloured fluid, a superficial ecchymosis may go on extending in all directions for many days.

The foregoing observations on ecchymoses relate to cases in which blood and bloody fluid are infiltrated, and in which they are not perceptible to the touch. When the blood is all in one clot, or in a liquid state enclosed in a cavity, there may be no visible ecchymoses, or only some around the extravasated blood, but the blood may be detected by the touch. When liquid, and among soft parts, it may be felt as a fluctuating swelling, usually very soft and flaccid, like liquid in a half-empty bladder. When thus extravasated over bones near the surface (as those of the vault of the skull), the blood commonly feels like a circumscribed swelling, soft at its centre, hard at its border; and the depth to which the centre may be pressed-in often makes it seem as if the bone were depressed. But, with the deepest pressure, the bone may be felt at its right level. In many of these cases, too, the blood pressed to and fro gives to the fingers a peculiar vibratory sensation (called, by some, crepitation), like that of fluid in certain bursæ and sheaths of tendons.

When contusions are not complicated with other injuries, and when the hurt parts do not slough or inflame, their effects usually terminate with the absorption of the extravasated fluids, and the recovery of the tissues from whatever injuries they may have sustained. The repair of the tissues is usually so complete that, after even severe contusions, such as those which accompany fractures, no traces of their injury can be seen. The liquid parts of the blood, when infiltrated, are generally absorbed quickly. The blood-cells and other materials of clots are very slowly removed. I have found the blood-cells, in the little ecchymoses of leech-bites, unchanged a month after their extravasation, and small clots and diffused blood in the neighbourhood of simple fractures scarcely changed at the end of five weeks. The larger the clot, the slower is its removal; and the extreme of slowness is found in the collections of extravasated blood that remain wholly or in great part liquid. In these cases, which are most frequent in contusions of the loins, nates, and other parts with extensive and loose subcutaneous tissue, the blood may remain for many weeks with apparently little change. If let out, it will generally coagulate like ordinary blood; if left, it may be gradually absorbed, or, decomposing, may excite active inflammation. The boundaries of the space in which blood is thus long retained may become firmly defined, and cyst-like; capable, perhaps, of secreting serous fluid which may mingle with the blood within them; certainly capable, after inflammation, of granulating and assuming all the characters of the walls of an abscess.

There is sufficient reason to believe that blood extravasated in a contusion may be organised; acquiring the characters of connective tissue, becoming vascular, taking part in the repair of the injured tissues, or in the thickening and induration that remain when the repair is incomplete. For although, so far as I am aware, this process has not been traced after simple contusions, yet evidence of it may be found in blood extravasated near fractures, in the clots in tied or injured vessels, and in not a few other instances. Nevertheless it is not probable that this organising of blood is frequent after contusions; and the more exact the researches that are made, the less reason is there found to adopt the belief that blood extravasated in a contusion can become a tumour of any kind. Contusions are, indeed, sometimes followed by the growth of tumours, but the event, if we compare its frequency with that of contusions, might almost be called infinitely rare; and there is no instance in which any of the stages of transition have been traced between the materials of extravasated blood and those of a cancer or any other tumour. It may be added that, even if such transitions could be traced, a yet greater difficulty would remain unexplained, namely, the power of continuous growth possessed by the new materials.

In some cases, especially when the contusion is severe, or the extravasation very large, or the general health of the patient unsound, the contused part becomes actively inflamed; the blood appears to act as a foreign body; probably, being mixed with the products of inflammation, it dies; and the usual result is, that it is ejected with suppuration. The abscess-cavity (as that which contained the extravasated blood has now become) generally continues, for many days, to discharge blood-stained pus; but at length it assumes the ordinary characters and progress of a common abscess. The probability of suppuration ensuing is greatly increased, if the contusion be accompanied with an external wound, however small. Indeed, the existence of such a wound commonly makes the same difference in the progress of a contusion as in that of a fracture.

Sloughing, as a consequence of contusion, has been considered in another place (Gangrene, p. 183).

Complete recovery, as already stated, is the ordinary termination of contusions. Yet certain prolonged, or permanent, ill consequences may be not rarely noticed. Sometimes the injured subcutaneous tissue hardens and contracts, forming a kind of subcutaneous scar, marked by a dimple in the skin. In some organs (chiefly the breast and the testicle), abscess may ensue long after a bruise; more often an indurated lump remains, consisting apparently of hardened and contracted gland-tissue, and often exquisitely sensitive. Still more commonly, a blow on the breast is followed by long-continuing pain and tenderness, without change of texture. Blows on the skull and other superficial bones are sometimes followed by persistent, circumscribed, and very painful thickenings of the periosteum. A muscle violently struck may be paralysed, and then may rapidly waste. A nerve similarly injured or crushed may remain paralysed, or become the source of extreme pain, or other morbid sensations. And any contused part is likely to become the seat in which any constitutional disease present at the time of, or soon after, the injury, will localise itself: witness, the apparent election of bruised joints or muscles for the local attacks of gout and rheumatism, and of bruised bones for syphilis or struma. Even small-pox will be more thickly confluent over a recent bruise than over any other part. Probably, the growth of cancerous and other tumours in bruised parts belongs to the same class of facts.

The treatment of recent simple contusions of the less severe degrees needs but few words. Left to themselves, in the quietude necessary for avoiding pain, natural recovery will ensue. But the clearing-up of the swelling may be hastened, and ecchymosis may be diminished or prevented, by certain stimulant applications, the best of which seems to be the tincture of arnica. When the skin is thick, this may be gently rubbed-in on the bruised part, undiluted; with thinner skin it should be diluted with an equal quantity of water. Or, it may be applied constantly, as a lotion, if diluted with about six times as much water. Other means for the same purpose, which have the testimony of popular reputation, are Friar's balsam, Riga balsam, and poultices made with roots of black briony beaten into a pulp. These, and all other local stimulants, such as the compound soap-liniment, probably act by accelerating the circulation through the bruised part, and the absorption of the fluid on which the early swelling, and, in slight bruises, the greater part of the ecchymosis, depend.

In more severe, and in complicated, contusions other treatment may be necessary. In severe cases, with much breaking or crushing of the tissues, the parts should be kept warm, both for comfort's sake, and because cold, by further retarding the circulation, increases the risk of sloughing, or of destructive inflammation. Wrappings with cotton-wool, or, better, with lint thoroughly soaked in oil, are among the best means; covering the part with warm poultices of linseed, or of linseed and bread, is perhaps as good. The design, however it may be fulfilled, should be, to combine rest of the injured part with uniform warmth, and the exclusion of air.

The treatment of the extreme cases of contusion has been described with that of traumatic gangrene.

In cases of excessive effusion of blood from contusion, ice should be applied, and the injured part be raised, so long as there appears any tendency to increased swelling.

When the extravasated blood remains in large clots, or in liquid collection, friction and kneading will probably accelerate its removal by diffusing it in the surrounding parts; and, if need be, such treatment should be continued very long. If there seem, after long treatment, no prospect of the blood being removed, it may be let out by puncture. A small puncture should be made, and if the blood be all liquid, it should be all removed, and the puncture closed, and the walls of the cavity compressed, in the hope that they may unite. But if this fail, or if the blood be for the most part in clots, it is best to make a very free opening, and let the cavity suppurate, and treat it as an abscess.

The inflammation that follows quickly after the less severe contusions rarely requires special treatment. That which ensues later, and is connected with changes in the clots, is so nearly sure to end in suppuration, that it may be treated as for the formation of abscess; and the abscess resulting should be freely opened, and daily washed out, till all the blood-clots are removed. Thenceforward its course will be that of an ordinary abscess.

JAMES PAGET.

WOUNDS.

WOUNDS are the divisions, or solutions of continuity, of soft parts, produced by external direct mechanical force. For systematic study they are sometimes classified according to their direction, or depth, or locality; but the most useful arrangement is based on the modes of their infliction. In this, they are divided first into open wounds, and subcutaneous; the former including those in which the outer part of the wound is at least nearly as extensive as that through the deeper tissues; the latter, all those in which the outer part of the wound is very small in comparison with the deeper part. In each of these kinds of wounds, but especially in the first, a further division is made into (1) incised wounds; cuts or incisions, including wounds of excision by which portions of the body are cleanly cut off: (2) punctured wounds; stabs, pricks, or punctures: (3) contused wounds, or those combined with bruising or crushing of the divided parts: (4) lacerated wounds, in which the division of the tissues is effected, or combined, with tearing of them: (5) poisoned wounds; including all into which any poison, venom, or virus is inserted.

Any wounds, of whatever class, may be either simple or complicated, *i.e.* attended with excessive hæmorrhage, or pain, or the presence of dead or foreign matter. Many wounds, moreover, are such as cannot be precisely assigned to any one of these classes; for they have characters either combining or intermediate between those of two or more of them; but convenience of study will justify both the making of classes, and the description of typical specimens of each. The arrangement indicated above will therefore be here followed. The general part of the pathology and treatment of wounds will be included in those of incised wounds, because these have been most fully studied, and, in their surgical relations, are by far the most important. Then, what concerns wounds of the other kinds may be much more briefly and specially described.

Simple open incised wounds are best exemplified by simple incisions made in surgical operations, or by accidental clean cuts with sharp-edged instruments. And three things, chiefly, are to be observed in them, viz. the opening or gaping by the retraction of their edges, the bleeding, and the pain.

Gaping of wounds. The width to which an incised wound opens by the separation of its edges varies greatly in different tissues, and in different conditions of each. For a general rule, the order in which M. Nélaton* arranges the tissues, according to their respective degrees of retraction when divided, is sufficient, namely, skin, elastic tissue, cellular tissue, arteries, muscles, fibrous tissues, nerves, cartilages. But within this general rule are many particulars.

The retraction of divided skin depends on its elastic tension, on its muscularity, and on the state of the parts beneath it; and each of these may vary. The tension does so in different postures; as, when the knee is bent, a wound across the thigh gapes more widely than when the knee is straight. Generally, too, longitudinal wounds of the limbs and trunk gape less than transverse ones do. The retraction due to the muscularity of the skin cannot be distinguished, at first, from that due to its elastic tension; but soon after an incision, its effect is seen in the curling, or turning in or out, of the edges of the wound. Thus, in flap-amputations, the edges of the skin commonly become everted before the stump is dressed; while in wounds of the face, as for hare-lip, they rather become inverted. Probably, also, it is to the muscularity of the skin that that great retraction is due which sometimes takes place after amputations. For the influence of subjacent parts in the retraction of divided skin, one may compare a wound into the mammary gland, especially during lactation, with one in the sole or palm. The edges of the latter may remain nearly in contact, while those of the former may dispart till the width of the wound is nearly equal to its length. Examples such as these may suffice to indicate that although, as a general rule, a wound of skin will gape or retract more widely than that of any other structure, yet for good treatment every wound may require particular study.

The incisions for flap-amputations, or for tying deep arteries, will generally show how much less than the skin the deeper tissues, when wounded, retract their edges. Some structures, indeed, compressed by the retracting skin, appear to project from the wound; such as soft fat, and mammary gland; and these may illustrate the protrusion which sometimes happens when structures under firm pressure are exposed, through wounds in fascia or comparatively inelastic membranes. Thus, in penetrating wounds of the abdomen, portions of omentum may protrude and be tightly girt by the edges of the wound in the peritoneum, through which they are, as it were, buttoned. So I have seen the lump of fat on the buccinator tightly buttoned through a small wound in the interior of the cheek: and a similar protrusion and tight girthing of muscle or fat is probably a frequent cause of the troubles that follow penetrating wounds through strong fasciæ. The eversion of the mucous membrane of a wounded intestine through the opening in its peritoneum is an event of the same kind.

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* *Elémens de Pathologie Chirurgicale,* tom. i. p. 106.

The retraction of wounded tissues, hitherto spoken of, is that which they display directly after division, and which is shown in the immediate gaping of the wounds. But, long after this, if they be not restrained, many of them continue to retract. Thus, in stumps that heal slowly the muscles retract far, giving the conical shape; and arteries which, when first divided, may appear on the face of a wound, draw far away.

The bleeding from an incised wound depends, as to its quantity, on many conditions; chiefly, on the size of the blood-vessels divided, on their number in proportion to the extent of the wound, and on their connexions with surrounding parts. Besides, the personal peculiarities of the patient, and the health or disease of the wounded part, may have great influence. It might be supposed that, at the instant after division, every vessel would bleed, with a stream equal to its own calibre: but, when one watches how little, if any, blood flows from a wound except in distinct and visible streams, it seems evident that of the crowds of vessels that are seen in well-injected specimens of the tissues, nearly all must close during or instantly after their division. The mechanical irritation of the knife, probably, excites the muscular tissue of both arteries and veins to this contraction; and it is assisted, in open wounds, by the contact of the air; and in all wounds, by the release of many of the capillaries and veins from the pressure of the blood, which ceases to be supplied to them in full quantity, when the arteries related to them are divided. Whatever hinders this contraction of the vessels prolongs and increases the bleeding. Hence the occasionally large bleedings from comparatively small vessels traversing or connected with tough, close textures, such as the small arteries in or near aponeuroses and fasciæ, or in the more compact parts of the skin, *e. g.* of the face. So, in inflamed parts, or in those near the seats of active disease; the dilated vessels bleed largely and long when divided, because of the loss of contractile power in their muscular coats.

Gradually, with or without surgical help, all the vessels divided by a wound are closed and cease to bleed: the larger being often aided to this end by their retraction among the looser textures, and by the coagulation of the blood within or over their orifices, and by the diminution of the heart's force with the increasing loss of blood. Coincidently, the flowing blood becomes gradually brighter and paler. And, if the wound be left open, after pure blood has ceased to flow, there is an oozing of blood-tinged serous-looking fluid; and this is gradually succeeded by a paler fluid, some of which collects, like a whitish film or glazing, on the surface of the wound. It contains very numerous white blood-cells, imbedded, apparently, in a fibrinous film. Its relation to the healing process will be considered hereafter (p. 585; and further, on bleeding see p. 602 and WOUNDS OF ARTERIES AND VEINS, and HÆMORRHAGE).

The pain of an incised wound cannot be usefully described, for it is so far peculiar that many of the terms applied to it can be intelligible to none who have not felt it. Sharp and cutting, at its infliction; then for a short time diffusely hot or burning; and then smarting till it gradually subsides into a feeling of mere stiffness,—thus to describe it may remind those who have experienced it, but to others may teach no more than a description of colours to one who is colour-blind. Besides, there are great differences in the degree, and perhaps also in the kind, of pain felt by different persons suffering with similar wounds. Some seem scarcely sensible; others, equal in fortitude, suffer most keenly. All suffer more, the more their attention is directed to the pain, and the more the mind has been sharpened by waiting and fear. An unexpected and unseen wound may be unfelt. There are also differences in both the kind and the degree of pain according to the place and manner of the wound. Thus, in regard to the skin, wounds of the face and of the extremities of the fingers and toes seem to be among the most painful; those of the back among the least so: wounds cut from within are less painful than those from without. The skin appears far more sensitive to wounds than any of the deeper structures, except the nerves of sensation themselves; but any part may become by disease, or distension, highly sensitive. A medical friend, who twice watched operations for inguinal hernia performed on himself, said that none of the pain surpassed that of dividing the tense fibres of the aponeurosis and the tight mouth of the sac. Periosteum, also, sometimes shows acute sensibility when cut; so do tightened tendons.

The consequences of incised wounds can scarcely be studied in men, free from the interference, for good or evil, of treatment. In some cases, indeed, even of large wounds, they are so trivial that they are unobserved; yet, after the majority of such wounds as are made in surgical practice, changes ensue, both local and constitutional, which are not necessary parts of the healing process, but rather hindrances to it.

The local consequences are characteristic of a certain amount of inflammation. In an hour or more after the wound (and generally, the interval is the longer, the more considerable the wound, and the greater the shock), the edges of the wound, and the parts adjacent to it, become swollen and more sensitive; they feel hot, and heavy or aching, and are more tender when touched; the sutures (if any have been put in) become tighter; and the edges of the wound, or of the spaces between the sutures, if not secured, gape open, because of the swelling and uprising of the subjacent structures. All these consequences of wounds may be best seen on the face; where, also, the chief cause of the swelling is often evident, in the serous-looking fluid by which the skin, especially of the eyelids, is puffed up.

In ordinary well-doing cases, these signs of inflammation continue from one to three or four days, and then spontaneously subside. The shorter their duration, the more perfect the healing. Their longer duration usually indicates disease, or some abiding source of irritation at the wound, and will be considered among the complications of wounds (p. 608).

Of the general consequences of wounds the first is the *shock*. In small incised wounds none may be observed; and when in any case it does occur, it is scarcely possible to say how much depends on the wound itself, and how much on the circumstances in which it was inflicted, or on the pain and fear and loss of blood. But the whole of this subject is treated in another place (COLLAPSE).

Reaction. The intensity of the shock commonly determines the time, and, in a less degree, the intensity, of the reaction which, in the ordinary course, immediately follows it. In some cases, indeed, even after severe wounds and much depression, the reaction does not go beyond the recovery of the natural standard of the heart's action and of other functions. The patient merely recovers, and may have no fever or other signs of general disorder; and the repair of the wound may make unhindered progress. But in far more numerous cases of considerable wounds, and especially in those that are not well closed, the reaction passes this normal limit: the pulse and breathing become more rapid, the former in a greater ratio than the latter, particularly when there has been much loss of blood; the pulse also is generally fuller or harder; the skin is flushed and feels hot; thirst is increased, and appetite lessened; the water of the urine is diminished; the bowels are inactive; the tongue usually white-coated, large, and moist; the sleep is short and often disturbed.

The duration of this state of feverish reaction or traumatic fever is variable, and bears no definite proportion to the severity of the injury; or, so far as is yet known, to any of the events connected with it. Not rarely, it subsides within twenty-four hours; more often, after large wounds (as those of amputation), it continues, with little diminution, for three or four days, and then gradually subsides; the pulse and breathing returning to their natural standard, the skin secreting more freely than natural, and becoming soft, and usually rather pallid and delicate in tint; the muscular power remaining less than natural. The commencement of suppuration in open wounds often coincides with the subsidence of the traumatic fever, but is no cause of it; for the same series of events commonly occurs where no suppuration takes place.

The continuance of signs of fever for more than four or five days after an incised wound, argues the existence of some abiding irritation, or of some morbid state complicating the injury; but it is not usual for the common and almost normal traumatic fever to pass straightway into any worse form, such as that of erysipelas, or pyæmia, or the surgical fever (so called). Any of these may, indeed, ensue during the traumatic fever; but they more commonly occur at its close, or after it has subsided, or even in the period of convalescence. Indeed, the liability to these specific diseases constitutes one of the most singular, and as yet unexplained, characters of the state of system following wounds.

The healing of open incised wounds may be accomplished in five methods, if we include those in which the process is assisted by treatment: viz. (1) by immediate union, or union by the first intention; (2) by primary adhesion, or union by the adhesive inflammation; (3) by granulation, or by the second intention; (4) by secondary adhesion, or the third intention, *i. e.* by the union of granulations; (5) by scarring under a scab, the so-called subcrustaceous cicatrisation.

Healing by immediate union consists in the simple conjoining or reunion of the wounded parts: no new material is formed to connect them; but being placed in contact and so maintained, they first merely stick together, and then become continuous.

The best examples of this mode of healing may be seen when flaps of skin have been raised by simple dissection, and then replaced on the subjacent parts; as, for instance, in the removal of a tumour or of a mammary gland. Within three days, or, in small wounds, within one day, the union may be complete, and little or no trace may appear of the line or plane at which the parts were separated. The process is so simple that it is best described by negatives. No sign of inflammation is observed; no evident afflux of blood; no exudation of reparative material; no scar; and no other conditions are required for the process than coaptation of the wounded surfaces, and the absence of inflammation at them.

Healing by primary adhesion, or adhesive union, is best seen in the cut edges of skin when they are brought near or into contact, and so maintained; *e. g.* after the operation for hare-lip, or after plastic operations. Sometimes, indeed, such wounds heal, at least in part, by immediate union; but more commonly, as the formation of a scar testifies, they are united by a new material, lymph, the product of adhesive inflammation.

The lymph in this method of union being placed on both the cut surfaces, and probably exuding or growing alike from both, combines them. Very little, if any, is infiltrated beneath the surfaces. Appearing to the naked eye as a ruddy or a pinkish-white, soft, and adhesive substance, it shows with the microscope cells like those of granulations, in their several stages of development. As it organises itself and becomes vascular, receiving blood-vessels from both the cut surfaces, so it gradually more and more firmly connects them; and it ends by forming between them a layer of connective tissue, covered with thin shining cuticle.

The first portions of this process, extending to the time at which the lymph becomes vascular, may be accomplished within forty-eight hours. In the case of small wounds, the process begins almost immediately after their infliction; in that of large wounds, a period of rest or inaction intervenes, of which more will be said presently. The later parts of the process are comparatively slow; and at the distance of a week or more from the infliction of the wound, if any thing tends to separate its edges, the lymph that unites them, being still soft though very vascular and not unhealthy, will suffer gradual elongation and attenuation till it may finally give way.

Healing by granulation may be exemplified by any incised wound left open and kept moist. Such a wound becomes, as already described (p. 581), coated, or, as it were, glazed over with a whitish film, containing abundant white blood-cells. If the surfaces of a wound thus glazed be brought together, they will unite, the film probably becoming organised and forming part of the bond of union. If they be left open, the film increases, so as to form a thin grayish or yellowish-white layer, which takes part in the formation of granulations.

But before granulations form, a period elapses, varying from two to ten or more days, according to the extent of the wound and the tissues involved in it, in which no visible change occurs in the injured parts. Probably, during this period of incubation, as it is called, the blood is stagnant in the vessels for some little distance from the wound; and the renewal of its streams, and their increase in size, by such an afflux as ensues in inflammation, constitute the first visible step in the healing process. The change in the supply of blood may be best seen on the margin of cut skin, where it commences in from two to four days after the wound; or of bone, where it commences on cancellous tissue in about a week, and in compact tissue in ten days or more.

The first appearance of granulations, which may commonly be seen in less than a day after the appearance of increased vascularity, is that of a layer of soft adhesive white or pale-pinkish substance on the surface of the wound. In another day or less, this may become vascular, with blood-vessels growing into it from those of the subjacent parts, and then, while it gradually increases to about a line in thickness, it acquires all the characters of granulations—a bright ruddy substance, soft, elastic, easily broken, succulent and abundantly vascular, granulated on its free surface, and at its attached surface intimately united with the tissue on which it is placed.

In minute structure, the new-formed granulations consist of cells, like those of inflammatory lymph, heaped together without apparent order, and connected by very little intermediate substance. Blood-vessels with walls of simple membrane extend into the cellular mass from the subjacent tissues. The largest vessels pass in lines directed nearly straight towards the free surface of the granulations, communicating on their way by many branches, and ending near the surface in loops or arches.

The further stages of the healing process consist in the gradual development of the substance of the granulations into those of a scar, *i.e.* into fibro-cellular or connective tissue, and a superficial layer of epithelium. The former is developed progressively from the deeper to the more superficial part of the layer of granulations; the latter, from its borders to its centre. With the progress of this development, the layer of granulations becomes paler, drier, thinner, and less vascular; and as the epithelium forms on it, it becomes smoother, and changes its ruddy tint to a dim purple or pink.

The completion of the healing, whether by adhesion or by granulations, is attained by the gradual improvement of the scar; the connective tissue becoming more and more like that of original formation, both in its own elemental structures and in the paucity of blood-vessels, and the cuticle becoming thicker and more opaque. Both structures, also, acquire characters adapted to the particular positions that they occupy. Thus, the scars of healed muscles and tendons are much tougher than those of healed skin: the latter, also, commonly acquire at length elastic fibres, and the cuticle of each scar becomes like that of the adjacent skin; and, even beyond this, improvement continues in the gradual loosening of a scar from its adhesions to surrounding parts. This is effected, chiefly, by the changes ensuing in the tissue of that part of the scar which is subcutaneous, and which gradually becomes looser, less tough, and more occupied with fat.

During the whole period of the development of granulations, and the perfecting of the scar, a process of contraction goes on which greatly accelerates the healing. Thus, if the healing of a stump be watched, the healthy skin may be seen drawn-in and puckered before any cuticle is formed on the granulations, unless at their very margin; or, after the removal of any portion of the scrotum, the diminution of the granulating surface is evidently due more to its own contraction than to the formation of epithelium on it. By the same continued contraction new scars become gradually more depressed, and shorter, and draw more closely together the parts that they unite.

Again, while granulations are forming, and till they are covered with cuticle, or "skinned over," pus is constantly being produced on their free surface. The earliest exudations flowing from open wounds are albuminous liquids, nearly clear, viscid, ready to dry into adhesive scabs, and containing comparatively few cells. The gradual transition to the characters of genuine pus indicates a corresponding progress in the formation of granulations, and thenceforward their characters are mutually indicative. Healthy and developing granulations always produce, and are indicated by, normal pus, *i.e.* by pus which is creamy, opaque, uniformly liquid, yellowish-white, and sufficiently abundant to cover completely the whole surface of the granulating wound. On the other hand, all defects and diseases of granulations are attended with morbid characters of pus.

Healing by secondary adhesion, or, as it may be called, by the third intention, is accomplished by the union of two granulating surfaces (*e.g.* those of two flaps after amputation) placed and maintained in contact. In this state the two surfaces simply unite, or else new material, produced from either or both surfaces, adheres to both, is organised into continuity with both, and thus unites them. The two layers of granulations thus form one layer, which, however, having no free surface, produces no pus, and is gradually developed into connective tissue. The process is very similar to that of healing by primary adhesion; but in that the lymph on the cut surfaces is not developed into granulations before the union. All granulations, however, will not thus unite; they must be healthy, not like those of sinuses, not profusely suppurating, not exuberant or œdematous.

Healing by scabbing, or under a scab, is the most natural, and, in some cases, the best, of all the healing processes. Very commonly, in animals, if a wound be left wide open, the blood and other exudations from it dry on its surface, and entangling dust and other foreign bodies, form an air-tight and adherent covering under which scarring takes place, and which is cast off when the healing is complete. The exact nature of the process has not been watched; but it seems to consist in little more than the formation of cuticle on the wounded surface, and it has the advantage that, as no granulations are produced, there is little or no contraction of the scar. In man the same process is less frequent; it is more apt to be spoiled by inflammation producing exudations under the scab, which either detach it or prevent the healing of the surface beneath it. Sometimes, however, the blood shed from a wound coagulates and dries on it, and remaining as a scab, permits healing under it; or, if this do not happen, a similarly effective scab may be formed by the serous fluid or lymph by which the surface of an exposed wound usually becomes glazed; or, more rarely, the pus of a granulating wound may scab over, and sound healing take place beneath.

Such are the several modes of healing of simple incised wounds, using them as a type of all open wounds. But, before speaking of the treatment by which each mode may be favoured, it may be well to indicate the nature of the processes engaged in them.

Nature of the healing processes. After every wound there is some tendency to an inflammatory process; and this is the greater, in general, the larger the wound, the longer its exposure to the air, and the greater the violence with which its infliction is accompanied or followed. This tendency to inflammation may not proceed beyond an increased sensibility of the part and an increased supply of blood. There may be no inflammatory exudation or formation, and where this is absent there may be the best healing. Or, where the inflammatory process goes on to the production of lymph, there it may cease; and the sooner it does so, the better for the healing.

Thus, in healing by immediate union, inflammation is a hindrance, if it proceed to exudation; for no new material is required; the divided parts should simply and directly reunite; and if any inflammatory product be formed between or near them, it either retards, or, at the best, does not assist their union.

In healing by adhesion, an inflammatory process, with exudation, ensues, and may generally be regarded as necessary for the production of the new reparative material. But it should not go beyond this; its continuance is a hindrance to that organisation of the lymph which is essential to complete adhesion.

So in healing by granulation. If inflammation be present (and the lowest degree of it is best), it is only for the production of the first material for granulations. Their organisation and continued healthy formation are retarded, or completely prevented, by any persistent inflammation.

For healing by secondary adhesion, and for that with scabbing, the absence of inflammation is essential.

The treatment of incised wounds may be guided, in some respects, by these considerations. As a general rule, nothing should be done by which inflammation may be excited or increased. So much as may be useful for some of the modes of healing will ensue through the violence of the wound itself; more than this can be only mischievous. On the other hand, the inflammation that directly follows a wound very rarely requires any express treatment, except in the case of organs in which even a transient inflammation may be productive of serious mischief, such as the eye, the large joints, the peritoneum, the lung, and other internal parts. The treatment of wounds of these parts will be considered in separate essays; but it may be here observed that the occasional (and it is only occasional) necessity of active treatment after their wounds has no bearing on the question of the treatment of wounds in general; since such active treatment is designed, not for the healing of the wound, but for the safety of the part which it involves. Speaking here of only the general treatment of incised wounds, it may be repeated that a primary traumatic inflammation, *i. e.* such an one as ensues within the first day after a wound, needs no antiphlogistic treatment of any kind. It will spontaneously subside, and do less mischief than the intended remedy might do. The same may be said of the inflammation which may ensue or increase three or four days after large wounds, previous to the production of granulations. It will subside with their formation and the production of healthy pus, and needs no other applications than are comfortable to the patient. If inflammation should persist at a wound, or be renewed during its healing, it is almost certainly due to some of those complications of the injury which will have to be considered in another place (p. 608).

In the treatment of all wounds, the position of the part is of some importance. The chief rule concerning it is that it should be such as can be maintained long enough without great discomfort. No other advantage can compensate for the loss of rest, and the general illness, that are produced by painful postures of injured parts. When comfort has, as far as possible, been secured, the next objects should be that the wounded part should be relaxed, so that the edges of the wound may come near or together; that no part, and especially no muscle, should be on the stretch; and that the direction of the wound may be such as will allow fluids to flow away from some part of it. If these conditions cannot be obtained by any position of the wound, various methods of padding and of bandages may supply them; but these should never be resorted to unless it is clear that position alone will not suffice.

The particular treatment of simple incised wounds must depend, in great part, on the mode of healing which it is intended to promote. There are, indeed, comparatively few wounds of the kind, in which the healing by immediate union or by adhesion is not desirable, and worth attempting. The following are among the few: namely, wounds through many different structures, and exposing considerable surfaces of deep-seated bones, *e. g.* wounds for the removal of exostoses of the femur; deep wounds whose depth much exceeds their length, *e. g.* many of those that go through the mammary gland for the removal of deep tumours; wounds of which the sides or their deeper portions cannot be brought into good contact; wounds through acutely inflamed or otherwise very diseased parts; and those from which secondary hæmorrhage is likely to take place. Excepting these, there are very few incised wounds in which the simple and speedy modes of healing may not be attempted; and even with these, judicious padding may often prevent the only evil to which they are prone, namely, the collection of blood and other fluids under the closed integuments. Or, again, in many of these wounds, a partial speedy union may be safely obtained, by leaving a portion of the wound open for fluids to drain through while the rest is closed. It is often advisable to adopt this method in the healing of large and deeply cut stumps, or of large excavating wounds in the scrotum.

Treatment for primary union of wounds. If the healing by immediate union or by adhesion be designed, the following are the chief things to be looked to: the arrest of bleeding; the cleaning of the wound; the exact apposition of its edges; their maintenance in this position; the exclusion of the whole wound from the air.

For the *arrest of bleeding*, if there be considerable vessels, they must be tied, twisted, acupressed, or crushed at their ends. But all these means, and especially ligatures, are hindrances to exact and close union, and should be avoided unless for the arrest of bleeding which is likely to be really injurious. Small vessels will spontaneously cease to bleed if exposed to cool air, or when the edges of the wound are pressed together; and such spontaneous closure is more favourable than any other to speedy healing. It is desirable for the security of such healing that the surfaces of the wounds should be completely clean of blood when they are brought together; but it is not essential that they should be so. The less blood there is on them, the better; all clots and liquid collections of blood should be carefully removed from them: but it is not essential to stay from putting-up a wound till not a drop of blood can be seen to flow; and it is not commonly advisable to do so, unless a renewed and increased bleeding is to be expected. Of the numerous means for arresting bleeding from small vessels, those which are least hostile to speedy healing are, cold air, water applied either to the wound or to its immediate neighbourhood, and pressure with dry lint.

The cleaning of the wound from all foreign matter should be complete; but, like all other proceedings for good healing, it should be accomplished without violence. Wounds should not be scrubbed even with sponges; they may be best cleansed with streams of water.

For the *apposition of the cut surfaces and edges* of wounds the chief means are, the various methods of padding and bandaging, sutures, and adhesive plasters. Of these, the first are adapted chiefly for the union of the deeper parts of large wounds, especially of the limbs and head; the others, for the more superficial parts of nearly all wounds.

Pads may be usefully employed in many wounds attended with excavation; as, in amputations of the breast or removal of axillary glands, or in some flap-amputations. Their utility is in securing the contact of those parts of wounds which are out of the reach of sutures, and which would be partially, if at all, compressed by plasters. They should be made of cotton-wool, fitted according to the necessity of the case, and retained in place by rollers or plaster, or many-tailed bandages.

Sutures, the modes of applying which are described in the part on MINOR SURGERY, find their chief utility in the union of integuments, and for this are valuable far beyond all other methods. The quilled suture is applicable to deep wounds; but is scarcely used except in plastic operations in the perineum. The twisted suture has its special value for wounds through the lips and cheeks; for some wounds into joints and the abdominal cavity. The uninterrupted suture, again, is adapted for only a comparatively few wounds; namely, those of the intestines and eyelids, and the superficial wounds of the palm and sole, in which the suture may be carried through the epidermis alone. The interrupted suture has no such narrow range of utility. Alone, or together with pads and bandage, or as complemental to the quilled and twisted sutures, it may be used for the union of all wounds for which speedy healing is desired. If there were any well-grounded objections against sutures of coarse silk or thread, they do not exist against those of metal, or of very fine silk or thread.

Except for very superficial wounds, plaster (with which may be arranged collodion and other similar materials) cannot be relied on for immediate or adhesive union. In other cases, its chief value is for supporting and compressing the deeper parts of wounds, and for bringing together the parts intermediate between sutures.

Coverings of wounds. A simple incised wound, when its sides are thus brought into complete contact, may be left exposed to the air. But, in general, some covering is advisable; and none is better than lint soaked in oil, and placed over the whole length of the wound, or over it and all the immediately adjacent parts. Wet or dry lint, however, may be used with little less advantage; or simple cerate on perforated linen. Whatever is used should be light, not adhesive, not ready to undergo or to favour decomposition, but sufficient to protect the wound from friction, dust, and sudden change of temperature.

No general rule can be stated respecting the time at which any, or the whole, of the dressings should be removed from a wound intended for healing by adhesion or the immediate union. In small wounds about the face, union may be complete and close in two days; but it is never so firm as to be safe from probable accidents; and it is among the chief advantages of metallic sutures that they excite so little irritation that they may be left in their places for any time requisite to make union secure against all probability of failure. It is, therefore, rarely advisable to remove them or any part of the dressings, unless it be the outer covering for cleanliness, before the lapse of four days, and for large wounds they are better left for seven or more; since, even when there is tendency to retraction of edges, the sutures will restrain and limit it, without doing any damage. Even when, with this retraction or tension, they 'cut out,' they do no harm. In short, they may be kept in as long as there is any hope of obtaining either primary or secondary adhesion, provided they do not prevent the escape of pus or other exuded or decomposing fluids.

If, at the first dressing, the union or adhesion of the wound be in good progress, the rules for later dressings may be few. Whatever sutures are removed (and it is seldom proper to remove all at once) should have their places taken by strips of plaster or of lint with collodion: the union, or the scar, should not be cleaned too scrupulously; it should be protected even from the plaster with oiled lint; and should be touched, if at all, as gently as an embryo, —for such it is. The daily, or less frequent, dressings of the part may be made in the same general manner; and, if all has gone well, the union of small wounds may be deemed safe at the end of a week, and that of larger ones at the end of ten days or a fortnight. But, to the last, recent scars are subject to diseases and defects from which they need to be protected by gentleness and the maintenance of good general health. More will be said of these hereafter (p. 611).

The foregoing rules of treatment are all applicable for the reunion of excised parts.

For healing by granulation, if it be designed from the first, as it should be for such incised wounds as are enumerated in p. 589, the general rules about arrest of bleeding and cleaning are to be observed. If secondary hæmorrhage be likely to occur, the wound had better be left open to cool air, unless it be a very large one, or on the wall of the chest or the abdomen, or a large joint. When its surface is dry, it may be covered with dry lint, or sponge. If the edges of the wound through the skin come so near together that they would be likely to unite, or to prevent the escape of fluid from the deeper parts, they should be kept asunder with dry or oiled lint, pressed between them to the deeper part of the wound, but leaving space for efflux. If the wound be wide open and excavated and with uneven boundaries, it is good to fill it with dry lint, charpie, or the like substance, which may absorb its first exudations. Over any of these dressings, lint soaked in oil may be placed in a smooth layer; or wet lint covered with oiled silk, or other light waterproof material: and if the wound be of such a shape that 'bagging' is likely to take place with the flowing of pus into its lower part, this part should be supported with pads and bandage or plaster.

It is generally desirable that whatever dressing has been placed in contact with a wound intended for granulation should be left till, with the beginning of suppuration, it can be removed without violence or bleeding. This may be easily and safely done if the wound be not very large, and do not involve many different tissues; but in either of these cases, the discharges from some parts of the wound are likely to be decomposing while to other parts, not yet suppurating, the dressings are still adherent. To remedy this (but the interference should not be without evident occasion), it is advisable to accelerate the separation of the adherent parts of the dressings with heat and moisture, as with poultices, or ample water-dressing, or streams of warm water.

When the surface of the wound is granulating and, of course also, suppurating, the essential things in local treatment are, to insure its cleanliness, and freedom from all rough contact, and from accumulations of pus. These may, generally, be attained by daily washing with small streams of warm water from a sponge or syringe. The granulations should not be touched with any thing solid, neither should they be dried or scrupulously cleaned from all their pus, unless it be decomposing. After the cleaning, the dressings should be at once replaced, and the best are lint oiled or with simple cerate, or wet lint, or wet cotton-wool, placed, in one or more pieces, smoothly and uniformly in contact with all the parts of the granulating surface, and covered with oiled silk, gutta-percha tissue, or some similar substance. As a rule, granulating wounds should be thus dressed daily, and as regularly watched to prevent or remedy, by pads or other means, the accumulations of pus.

The same methods of treatment may be adopted whether the healing by granulation be desired from the first, or whether it be resorted to after the failure of an immediate or adhesive union. In either case, the process of granulation is liable to hindrances and defects of various kinds; but these, as well as the disorders of scars, which are most frequent in those formed from granulations, will be considered among the "defects and diseases of the healing process," at the close of this essay.

In the treatment for healing by secondary adhesion, the single object to be fulfilled is to bring two granulating surfaces into close, not tight, contact, and keep them so. In some cases (as after the first failure of a hare-lip operation), this may be done with sutures; but, where these are not applicable, as with large granulating flaps after amputation, pads and bandages may be used. Indeed, nearly all the rules for the treatment for obtaining a primary adhesion may be followed for a secondary one.

To obtain healing under a scab, if the wound be recent, the blood and exuded fluids, or, if it be granulating, the pus, should be left exposed to the air till it dries on the wound, adhering to the edges and surface, and completely excluding them from air. Nothing more need be done, unless that the scab thus formed should be lightly covered with dry cotton-wool to protect both it and the subjacent surface from whatever may excite inflammation. For it seems to be the proneness to this morbid process which makes the healing under a scab precarious and less generally attainable than one could wish it. No morbid exudation should take place under a scab once formed; every thing of the kind painfully compresses the wound and retards its healing.

In general, the healing under a scab may be allowed to take place spontaneously. But it may be favoured by methods either of so-called incubation, by keeping the wounded part in heated air, or of ventilation by frequent blowing of it with fans or bellows.

The scar formed under a scab is commonly firmer and healthier than any other. Yet it may need that which all scars, even the healthiest, do,—namely, such a covering as will keep it from violence, sudden changes of temperature, and excessive moisture. Cotton-wool, wadding, or silk, will best fulfil these purposes.

Respecting the general treatment of patients with incised wounds, few words may here suffice; since, unless they become the subjects of erysipelas, or some of those diseases to which it is a peculiarity of their state that they are especially liable (which diseases are described elsewhere), the treatment may be of the very simplest kind.

Preparatory treatment. When wounds are to be intentionally made, as in surgical operations, the rules as to preparatory treatment may be summed-up in the principle that a patient is in the best state for receiving a wound when he is most nearly in perfect health. All surgeons seem to concur in the opinion that it is not wise to reduce a patient's health, by bleeding, purging, or other such means, in the belief that he is thus well-prepared for an operation. If a patient be in good general health, no other preparation is necessary than a day's rest: if he be ill, that which is wrong should, if possible, be set right; if he have been ill-fed, he should be, for a time, fed-up; if he have been intemperate, he should be reduced nearer to moderation.

Treatment of reaction. The shock and collapse which may follow wounds are considered elsewhere. The reaction and fever which commonly next occur very rarely need treatment. Their natural tendency is to subside into health: and while, on the one hand, there is no advantage in increasing them by unusual stimulants, there is, on the other, no need to try to decrease them by purgative or other medicines. The patient during the state of reaction or of traumatic fever will generally be averse from solid food, and should not take it. Yet he should be well fed, on a mixed diet of easily digestible food; and if he have been accustomed to stimulants, their quantity should not be materially reduced, unless the signs of reaction or of fever are strongly marked. At the subsidence of the fever-symptoms, there appears to be a period in which erysipelas and other of the worst consequences of wounds are especially apt to set in. This period, therefore, may need close watching, with the design of increasing the quantity of stimulus and of food, if there appear indications of failing power, in a diminished force of the pulse, or in restlessness, or defective heat. If no such indications are observed, the patient may gradually return to his ordinary manner of living, cleared of whatever was imprudent in it, and modified according to the different habits to which his wound may compel him. At any time after a wound, opium may be given in any quantity necessary for sleep; plastic operations on the perineum, after which it is often advisable to keep the bowels constipated for ten or more days with opium, show that, even in this constant and large use, it does not interfere with healing, or with any of the ordinary favourable sequences of wounds. And the same cases, as well as many others, will show that the quietude of the bowels which so generally exists for three or four days after an operation, or any large wound, need not be disturbed with medicine. Unless there be some evident discomfort from constipation, a wounded patient is best without aperients: the bowels will act spontaneously in due time.

Treatment in convalescence. Through the period of convalescence after wounds, patients that have been healthy will commonly need no medical treatment. If they can move about in the air, they may be on full diet, or on such diet as they have been accustomed to; but, if they be confined in bed, or even in the house, they are apt to be over-fed, and should be supplied more sparingly. Especially, this is true of such as have required large quantities of stimulants in any of the complications of the wound or of its consequences. Such stimulants as may have helped to cure these complications will only hinder convalescence and the healing of the wound.

The period of convalescence is one in which erysipelas and such mischiefs become daily less probable; but scurvy, gangrene, and the consequences of syphilis, struma, and other constitutional affections in those who are liable to them, may appear in any part of it. The wound must therefore be watched for these, if there be any reason to expect them, and appropriate treatment be promptly resorted to. In like manner, the defective powers of old age are more often manifested in the later than in the earlier periods of the healing of wounds. The process flags in its last stages, and is apt to need for its completion ample stimulants, both general and local.

Having thus included in the pathology of simple incised wounds the greater part of that of wounds in general, it may suffice if the account of the other varieties of wounds include only such things as are, severally, peculiar to them.

Punctured wounds vary in their importance according, not only to their depth and the structures penetrated, but to the instruments inflicting them. If made with small sharp-pointed instruments, such as needles and trocars, they are rarely serious, and usually heal by immediate or adhesive union, unless they involve blood-vessels, or are inflicted on unhealthy persons or diseased structures. In these latter cases, they are peculiarly apt to be followed by inflammations of low type. They are more serious, if made with larger sharp-pointed instruments, as bayonets, daggers, and the like; and yet more so, if made with blunt-pointed instruments, such as nails, forks, teeth, &c.; for by these the injured parts are not so divided as that they may retract, but are pressed aside, with much bruising, and can close again as soon as the instrument is withdrawn. Herein lie the chief peculiarity and danger of punctured wounds; because whether blood or other fluids be extravasated into them, they do not afford sufficient facility for escape. The retained fluids decomposing, or by their mere pressure, irritate the adjacent structures, and are increased by the products of active inflammation. Hence may ensue deep and confined suppuration, and extensive separation of the tissues: mischiefs which are more especially apt to occur when the punctured wound extends through tough fasciæ, such as the palmar or the plantar, into looser subjacent structures.

The contrast between these worst punctured wounds, and the subcutaneous wounds which are made in surgery, and which are so rarely followed by any serious consequences, indicates that the chief source of the evils of the former is in the bruising and tearing of the injured parts, rather than in the peculiar shape of the wound. But the treatment of punctured wounds may be copied from that of the subcutaneous. A pad should be placed on the outer wound, the deeper portion should be moderately and uniformly compressed, and the part should be kept at rest. If no pain or swelling should ensue, the dressings may be left till the healing is complete; but, in case of pain ensuing after that first caused by the wound has ceased, they should be removed. This pain will, probably, be found due to inflammation of the deeper part of the wound; and the probability is the greater, the greater the time that has elapsed since the wound, and the more of œdema or general swelling that is present.

In cases of inflammation thus ensuing, the wounded part should be kept warm and moist. The orifice, if it be closed, may be reopened, or, in some cases, widened, to permit the escape of fluids. If no important part be wounded, it is seldom necessary or useful to apply cold, or to take blood by leeches or otherwise, or, in any way, to reduce the patient's strength. The pain may, for a time, be alleviated by these means, and for this purpose they may be employed in strong people. But these accidents of punctured wounds are especially apt to occur in those who are enfeebled, and in whom the better treatment is to give bark and stimulants, with local heat and moisture. In any case, when suppuration has ensued, if the original puncture be not sufficient for the exit of pus, it must be enlarged, or other openings must be made in suitable places.

Some of the worst forms of punctured wounds are those produced by sharp teeth, probably because of the force with which, as the teeth tend to meet, they crush the intervening parts. Of these, it is best not to attempt the union; they should be treated as contused wounds of the worse kinds.

Contused wounds are those which, being usually produced by blunt instruments quickly moved, are attended with evident bruising in the wounded parts. (Gun-shot wounds, which are of this class, are described elsewhere.) They are generally rough-edged and irregular (the less so, the more swiftly the instrument has moved), and commonly they gape less and bleed less than incised wounds of the same extent. Very commonly, also, they are attended with separation of the parts, especially of the subcutaneous tissue, both near and far from them.

In the treatment of contused wounds, it is always a first question whether it be advisable to attempt their healing by immediate or adhesive union. No general rule can be given, for the decision must depend on conditions peculiar to each case; yet it may be said that, when union is attempted, cases very often turn out much better than appeared likely, and that the failure of the attempt so seldom does harm, that it had better be made unless it is quite evidently hopeless.

For the union of contused wounds, the same rules may be followed as for the incised; but they especially need careful cleaning, removal of clots, and soft warm covering. There is no good objection to the employment of sutures, when the shape and extent of the wound do not render them unsuitable; and the general plan of dressing may be the same as for incised wounds, but with more watching for the supervention of deep inflammation or of sloughing. The former may be treated as when it occurs after punctured wounds; the latter may almost always be regarded as due not to mere severity of inflammation, but to the violence of the injury, or the defective power of the patient, or to both combined. These are, indeed, so usually the causes of sloughing after contused wounds, that it is very rarely, if ever, advisable to reduce the circulation of a part thus injured, with either cold or abstraction of blood.

When the union of a contused wound is not to be attempted, the part should be kept at rest, and, as nearly as possible, at its natural temperature. For the latter purpose and for protection, an excellent dressing is lint, or cotton-wool, thoroughly soaked in olive-oil, and completely fitted to the part. Dry cotton-wool may be applied over this, or oiled silk. Water-dressing may be similarly applied, or warm poultices; but they are generally less comfortable, and have the disadvantage of needing more frequent change. Irrigation is, in some cases, very soothing, especially in ragged wounds of the extremities; but it should be with tepid water.

The methods of the dressing, after the first, may be, in nearly every respect, the same as for incised wounds.

In the case of contused wounds about the face or other parts in which it is highly desirable to avoid large scars, it is sometimes proper to cut off rough or uneven edges, or such as are likely to slough, and sometimes to dissect-up flaps of skin, so as to bring together clean cut edges which may be very closely united. But the practice had better be regarded as only exceptional, for the parts in which small scars are desirable are just those that rarely slough extensively even when much contused.

Lacerated wounds, made by rending or tearing, rather than by cutting or breaking, of parts, are usually distinguished by irregularity, little or no bleeding, and comparatively little pain. The first character is probably to be assigned to the different elasticities of the structures torn through, permitting some to be much more stretched than others before they give way; and the second to the blood-vessels being pulled out before they are torn across, so that they are enabled freely and fully to contract and close their canals.

What has been said of the treatment of contused wounds might be repeated for the lacerated. The chances of union are not less; the most frequent causes of its failure are the same, and similarly to be guarded against.

Poisoned wounds owe their peculiarities so entirely to the substance by the insertion of which they are complicated, that they will be best considered with the general pathology of ANIMAL POISONS.

Subcutaneous wounds deserve study as a class distinct from all others, not only because of their special value in surgery, but because their consequences are, in many respects, different from those of open wounds of the same parts. They are exemplified in the wounds of tenotomy, and other subcutaneous operations, in which, through small punctures of the skin, some deeply-seated parts are more largely divided. Such divisions may be made by simple cuts; but, like the open wounds, the subcutaneous may also be contused or lacerated, as in those accidents in which, through a small external opening, a tendon is pulled out of its muscle.

The immediate effects of a subcutaneous wound, the separation of its sides, the bleeding and the pain, are less than those of an open wound of the same parts; but the greater difference is in their several consequences. Subcutaneous wounds, even of great extent, commonly heal with scarcely any signs of inflammation, and without suppuration, or traumatic fever; and in only very rare cases are followed by erysipelas or any of the graver dangers which open wounds may induce.

The characters of subcutaneous wounds, and their modes of healing, have scarcely been studied in any parts except the tendons; but, probably, both the one and the other are so essentially similar in all the soft parts, that what is seen in the case of divided tendons may be believed, with certain modifications, of all other subcutaneous wounds. The portions of a divided tendon are drawn widely asunder by the contraction of the muscle attached to one or both, and a gap is left to be filled by reparative substance. Other tissues subcutaneously divided retract but little, and some, such as the subcutaneous fat and connective tissue, and ligaments, probably scarcely separate at all, unless they are forcibly stretched. If no notable vessel be wounded, the blood shed is usually only such as in an ecchymosis may be infiltrated in the parts near the wound. If there be much retraction of the divided structures, air often enters the small external wound; but it is probably soon absorbed, and never appears to affect the healing.

This *healing of subcutaneous wounds* may be by immediate, or by mediate, union. If the parts after division do not retract, or are placed and kept in contact, they simply reunite. The process is the same as that for the immediate union of open wounds; one description may suffice for both. But when the parts are drawn asunder, by their own or other forces, the space between them is filled with reparative material which is gradually organised into continuity, and more or less of likeness, with them.

In the instance of subcutaneously divided tendons, the first apparent consequence, after the separation of the two portions, is the effusion of a fluid or semifluid substance resembling, in all respects, inflammatory lymph, and the product, probably, of an inflammatory process directly excited by the injury. It fills, together with small quantities of blood, whatever space remains between the disparted ends of the tendon, and is infiltrated in the tissues around and collapsed between them. The blood-vessels at and near the seat of injury enlarge; and all its appearance, for the first day or two, indicates a state of inflammation.

But this state, in ordinary well-doing cases, does not continue more than one or two days; and the inflammatory product takes little or no part in the healing of the injury; its cells are generally not developed beyond the caudate form, but rather degenerate and waste.

Two or more days after the division of the tendon (and probably a similar period would elapse after that of any other structures that retract), the reparative material is deposited in the space between the retracted portions, and in the tissue immediately investing them, and in that between their fasciculi. Similarly, it may be believed, such a material is deposited within and near and between any other subcutaneously divided and retracted soft structures; infiltrating them and the immediately adjacent tissues, and mingled with the inflammatory product of the earlier period after the injury.

The reparative material, which thus takes a similar office in the healing of subcutaneous wounds with separation of parts, to that which the material for granulations takes in similar open wounds, is not similarly developed. At first it appears as a soft, moist, grayish substance, with a slight ruddy tinge, which, in the microscope, looks finely molecular, or dimly shaded, like homogeneous or dotted fibrine. But, as the healing makes progress, this reparative material becomes firmer, tougher, and grayer, and more defined from the surrounding parts; till (keeping still to the example of the divided tendon) it forms a distinct cord-like vascular bond of connexion between the ends of the tendon, extending through all the space from which they are retracted, and for a short distance ensheathing them. Commensurately with its increasing strength and distinctness, the reparative material acquires more developed structures. Elongated oval nucleiform bodies appear in it, irregularly but densely placed; the intermediate substance, or blastema, acquires more and more a filamentous appearance, and then a filamentous structure; and as it perfects in itself the latter change, the nucleiform bodies become elongated and attenuated, and irregular as if with slight branching.

While these changes are taking place in the reparative material, the tissues about it recover from the first effects of the injury. Their blood-vessels regain their normal size, the inflammatory product is cleared away, and the several structures regain their natural mobility. Finally, the new-formed substance acquires not only the shape of the pieces of tendon which it combines, but a strength as great, and a structure nearly as perfect, as theirs.*

As already stated, the mediate healing of subcutaneous wounds of soft parts other than tendons may be assumed, but is not known, to be effected in the same manner. It is, however, certain that after all subcutaneous wounds, the healing, if it be not disturbed by some accident or disease, is achieved without the help of any inflammatory process, and that the materials of repair are not usually developed through cell-structures like those of granulations.

The treatment of subcutaneous wounds may be of the simplest kind, except in so far as it may need to be modified for orthopædic purposes. Irrespective of these, the only principles of treatment are, to give the wounded parts such a position as may be comfortably maintained and permit the least retraction; to close the external opening, with a small pad, or other simple application; and with a bandage, or any simple means, to keep the parts for a few days at rest. Thus treated, subcutaneous wounds will seldom fail to show the contrast between themselves and open wounds in the quietude and completeness of their healing; a contrast which appears to depend entirely on the one being exposed to the atmospheric air, and the other excluded from it.

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* The above description of the repair of divided tendons is taken from my observation of the process in rabbits. Mr. W. Adams has proved, by a valuable series of cases, that the process is in nearly every particular the same in man: *On the Reparative Process in Human Tendons*, 1860.

Complications of wounds. Passing now from the consideration of particular kinds of wounds, those complications must be described, to which any of them, or of their ordinary consequences, is liable. Of these, some are local, others general or constitutional: among the former the chief are, bleeding, *i. e.* more than ordinary bleeding, excessive pain, morbid muscular movements, and the presence of foreign bodies; among the latter, defect or excess of reaction, traumatic delirium, fever, erysipelas, pyæmia, &c.

Bleeding, or *hæmorrhage*, as a complication of wounds, may be in excess either at and continuously after the infliction of the injury, or, after ceasing, it may be at any time renewed. In the former case, it is usually spoken of as primary, or immediate, hæmorrhage; in the latter, as secondary. But among secondary hæmorrhages, it is advisable to distinguish those which occur within a day (or, in a few cases, two days) after the wound, from those which occur later. The former should be called 'recurring;' the latter may be especially called 'secondary.'

Nearly the whole of the surgery of hæmorrhages in connexion with wounds is included in other essays (see HÆMORRHAGE, and INJURIES OF ARTERIES AND VEINS). Here, only the most general facts connected with it will be stated.

The phenomena of primary hæmorrhage are already described (p. 580).

Recurring hæmorrhage is most likely to happen when the patient, recovering from faintness or the shock of an injury, regains that force of the circulation, of which the decrease had favoured the cessation of the primary bleeding. It appears to be more frequent during the process of reaction, than when reaction is completely established. It may be due to the slipping of an ill-applied ligature; but is more commonly to be referred to the relaxation of contracted vessels, or the removal of clots which had been sufficient to close vessels when the circulation was feeble. And there are certain wounds in which recurring hæmorrhage is peculiarly apt to happen; those, namely, which are deep and narrow, and whose sides are ill-supported (*e. g.* wounds of lithotomy, and those through the mammary gland), and those in which vessels in and near fibrous and bony structures are divided (*e. g.* in amputation at joints).

What has been said may indicate the cases in which more than usual precautions against recurring hæmorrhage should be taken. If there be much reason to expect it, even though all care may have been taken to close every open vessel, the wound should not be closed till the patient's circulation has in some measure recovered, unless, indeed, it can be so put up as to be, in every part, well supported or compressed. If not closed, the wound had better be left free to the air; if closed, it should be kept cold or cool, and only allowed to regain its heat slowly. In any case, if the hæmorrhage would be quickly dangerous, the wound should be watched constantly. If it be so closed that the blood cannot escape from it, the best signs of recurring hæmorrhage will be swelling of the parts about the wound, considerable and increasing pain, and, if the bloodshed be large, increasing feebleness of pulse, pallor, restlessness, coldness and dampness of the skin, of which the patient himself is not usually conscious. Symptoms such as these are more characteristic of a recurring hæmorrhage needing interference, than is a single small or moderate escape of blood from a wound: for this commonly happens after amputations, as if, in the swelling of the parts about the wound, the blood that had collected in it during and shortly after the dressing were emptied out.

For the *treatment of recurring hæmorrhage*, if it be to a small extent, it may suffice to put the wounded part in an elevated posture, and apply cold, with ice or cold irrigation, over the wound, and compress the supplying artery. These may avert the necessity of opening the wound, if it have been closed; and are very likely to do so if, as often happens, the bleeding be from some reopened cutaneous vessel. But if they fail, and the bleeding be deep, the wound should be opened, and cleared of all its clot; for, even though the bleeding be not profuse, it will spoil the healing process. As soon as the wound is opened, the bleeding is not unlikely to cease. If it does so, and no bleeding vessels can be seen, the wound should be left open to granulate, or at least till it becomes glazed, when, if reaction be complete and the speedy union of the wound be very desirable, it may be again closed. If, when the clots are removed, bleeding vessels, large enough for ligatures or other means of closure, are seen, they must be secured; and the wound may be closed again.

If the bleeding be from many vessels too small for ligatures, the wound should be left open to the air; or if the air have not free access, it should according to its shape be filled or plugged with dry lint made to press firmly on its bleeding surfaces. In some cases (but they are rare and admit of no general description) hæmostatics are necessary, of which the best are alum, or the perchloride of iron, or the actual cautery.

The danger of recurring hæmorrhage is, generally, past when reaction is completely established; but when such a hæmorrhage has much reduced the force of a patient's circulation, there is danger of its again recurring when reaction is again in progress. The same precautions, therefore, are necessary against the repetition, as against the first event, of a recurring hæmorrhage; and some of the same measures must be adopted for its remedy.

The later hæmorrhages, for which the name of secondary hæmorrhage should be reserved, are, with very few exceptions, due to morbid processes in the large vessels involved in the wound or its consequences. A ligature may be accidentally separated too early; or with over-feeding, the small vessels of the wound or its granulations may be over-filled and give way with considerable bleeding; or bleeding may occur through scurvy or the hæmorrhagic diathesis; but with these exceptions, the secondary hæmorrhages from wounds may be always referred to sloughing or ulceration of the walls of arteries, or, much more rarely, of veins. So long as a wound is in good progress of healing, in whatever stage, secondary hæmorrhage is a most improbable event: its probability is the greater in the same proportion as the wound and the immediately adjacent parts are prone to sloughing, or to ulceration which may involve the blood-vessels, or to morbid infiltration and consolidation of the tissues. In short, the blood-vessels are ready to partake in any of the morbid processes which may occur at a wound, and through many of these are in danger of giving issue to the blood.

Thus, all that relates to secondary hæmorrhage as a complication of wounds will be more naturally considered with the diseases and injuries of arteries and veins, and in the general pathology of hæmorrhage, to which separate essays are devoted.

Pain, as a complication of wounds, varies greatly in both kind and import. In some instances it appears only as an exaggeration of the ordinary pain of wounds, severe and abiding long, through personal sensibility and so-called nervousness. This, which is usually continuous with the immediate pain of the wound, or commences not more than an hour or two after it, may be remedied by full doses of opium. In some cases, a wound is a beginning of long-continuing neuralgia in or near the injured part; and such cases commonly resist all treatment, even that which, considering their local cause, might be thought a sure remedy, namely, division of the nerve supplying the part. In some, again, a long-abiding pain seems due to partial division of a nerve, and may be cured by enlarging the wound sufficiently to complete the division. The same proceeding suffices for another occasional source of unusual pain after wounds, namely, the confinement of swelling parts under dense fasciæ. Of course, if wounds become intensely inflamed, or if sloughing or deep suppuration take place, or if foreign bodies irritate them, they are generally morbidly painful; so they are when bandages are ill-applied, or sutures are too tight, or the injured part is put in a wrong posture. But the pathology of these cases is clear, and they are enumerated only because, when pain ensues as a complication of a wound, it is well to have in mind all the conditions on which it may depend, especially those last enumerated, which, in the case of recent wounds, are the simplest and most frequent causes of excessive pain. (On painful scars, see p. 611.)

Spasmodic muscular movements are not frequent complications of any wounds, except those of amputations. In these cases, 'jumpings' of the limb or stump are often among the most distressing symptoms. Similar movements often occur after resections; but generally, the stillness of muscles involved in wounds is more remarkable than their morbid activity. (Tetanus is not considered here; a separate essay treats of it.)

These spasmodic movements, like those which occur in severe diseases of joints, especially of the hip and knee, are most frequent during sleep. Commonly, as the patient falls asleep, and the influence of the will on the muscles ceases, he is awakened with a painful start of the stump or other wounded part; and the pain remains till the muscles are again at rest. Or, at any time, uncontrollable quiverings or tremblings of the muscles ensue, and soon lead to painful spasms of them.

Different patients suffer very variously from these spasms; but few escape them after amputations. The remedy may usually be found in careful posture and rest for the wounded part. As the similar spasms attending diseased joints are usually cured by perfect rest in splints, so are those of stumps and of resected limbs. Whatever means, whether splints or others, may be best suited for each case, must therefore be employed; and they may be assisted with opium.

Foreign bodies may variously complicate wounds, according to their material, size, and other properties. In general, metallic bodies and others that are hardest, least porous, and least ready to decompose, do the least harm. The instances are numerous in which pieces of these substances have remained imbedded in the tissues for many years after wounds, whose healing they seem not to have hindered. The probability of a foreign body thus remaining is the greater the less the wound that it has made is exposed to the external air, and the less the suppuration which it excites. Organic substances, on the other hand, and those that are porous and easily decomposed, rarely fail to hinder the healing of wounds in which they lie, or to give rise to later troubles if wounds have healed over them.

The consequences of a foreign body being lodged in a wound are generally not evident in the early stages of healing, unless it be in contact with some very sensitive or irritable structure, the excitement of which may attract attention. The effects of a piece of metal in the cornea, or of a shot within the eyeball, are painfully evident; but they have no parallel in the immediate effects of foreign bodies in less sensitive parts. Over these, it is common for wounds to heal completely, or, failing this, to remain only as sinuses constantly discharging, or frequently closing and reopening.

If a wound have healed, the pressure of a shut-in foreign body may be suspected when there is abiding pain, or tenderness, at some one spot, with occasional attacks of inflammation in or near it; and still more when a circumscribed hardness is felt at the spot, and the patient feels such pricking or cutting as the movements of the foreign body might produce.* On such suspicion it is often proper to cut into the suspected place and remove whatever irritates it: but whoever does so in many cases, will be disappointed in some; for all these signs of the presence of a foreign body may be exactly imitated by a painful induration of some deep portion of a scar. The chances of such disappointment will suggest caution in cutting for foreign bodies, even when patients are confident of their presence; but the risk must be often incurred, and it may be so the more readily, because the cutting will not unfrequently cure the painfulness of the deceptive induration.

If a foreign body, thus enclosed by a healed wound, be left in its place, it may become closely surrounded by healthy or indurated tissue, and cease to give trouble. This is most likely to happen if it be a metallic body; especially if it be of iron or silver, and not very sharp. If it be very sharp (as a needle), it may 'travel,' being moved by the pressure of the parts adjacent to it, or by its own weight. It may thus traverse considerable distances and important parts without damage; but the cases are not few in which such foreign bodies, penetrating joints, or blood-vessels, or other considerable structures, have caused serious mischiefs even very long after they first entered the body. All these cases corroborate the general principle of practice, that a foreign body should not be left, even under a healed wound, unless it is nearly certain that the operation for its removal will do more harm than is likely at any time to result from leaving it.

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* On the magnetic indications of the presence of iron bodies in the tissues, see a paper by Dr. Bence Jones, in the *Proceedings of the Med.-Chir. Soc.*, vol. i. p. 71.

The repeated inflammations to which enclosed foreign bodies, especially those of organic structure, often give rise, usually indicate or lead to suppuration, and the discharge of the foreign body with the pus. This termination should be encouraged. As soon as pus is evident, it should be let out; any assistance should be given which may be necessary for the removal of the irritating substance; and what remains should be treated as an ordinary abscess.

If the wound do not heal over a foreign body, there seldom remains more than a sinus leading to the place of lodgment. Such a sinus (unless it lead into a mucous canal or a large cavity) is almost characteristic of this complication of a wound; and not the less so if it frequently closes at the surface, and then reopens with increased discharge. Of course, the other signs of the presence of a foreign body may exist together with the sinus; and it may be within reach of a probe.

The removal of the foreign body, in the quickest and most convenient manner, is the one remedy for these cases. Slowly, or at once by cutting, the sinus must be widened, till the foreign body can be reached and extracted; or if, as sometimes happens, it cannot be found, and the sinus leads to an irregular track or deep cavity, this should be freely exposed, and filled with lint or some such substance, and healed from the bottom. If a foreign body be present, it is almost sure to appear before this healing is complete.*

The defects and diseases of the healing process and of scars remain now to be spoken of.

The healing process may be simply defective; failing entirely, or making very tardy progress. Thus, after a plastic operation, there is, sometimes, a simple failure of union (the parallel of the non-union of a fracture); or, when a wound is healing by granulation, its surface may become dry, glazy, pale, brownish, and its borders may lose their proper ruddiness and cease to contract.

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* The general or constitutional complications of wounds enumerated at p. 602 are treated in separate articles;—see COLLAPSE, ERYSIPELAS, PYÆMIA, &c.

It is sometimes impossible to assign the cause of these failures, just as it is with some cases of non-union of fractures. They are seen, occasionally, in very young children, *e.g.* after hare-lip operations; more frequently, they occur in old age, or the simple defects of health which are most like it. During acute disease, the healing of wounds is commonly suspended or much retarded; but in chronic affections, even in chronic pyæmia, it is scarcely interrupted; and even in extreme exhaustion, as after hæmorrhages or long-continued suppurations, healing may be perfect in both rate and method.

The general treatment of such merely defective healing must vary according to the general condition of the patient. The local treatment must generally be with stimulants, among which ointments or resinous substances are usually best, *e.g.* the Peruvian balsam, or unguentum resinæ, or a mixture of the two. The part should be kept dry and warm; and if the failure of healing have occurred in a wound intended for immediate or adhesive union, the sutures (unless they are evidently doing harm) should not be removed so long as even the smallest hope of union remains. They may assist in the union by the third intention, if the earlier methods fail.

Inflammation. In any stage of healing, *acute sthenic inflammation* may set-in, with swelling and its other usual signs. But, unless it be provoked by some evident local irritation, such inflammation becomes less probable as the time from the injury increases. It is most likely to occur in the cases of wounds of those organs in which, from ordinary causes, or as if spontaneously, active inflammation is most frequent, namely, the joints, the eye, the serous membranes. The effect of such inflammation is a total suspension of the healing process, and a speedy degeneration of the reparative structures which may have been already formed. They may give way, or waste; but they should be treated as if they would recover, for they often do so.

A more frequent form of acute inflammation affecting healing wounds and the parts near them is that of a low type. It usually commences after there has been a clear interval of recovery from the first irritation of the wound; and the longer the interval, the more nearly certain it is that an inflammation will be of this type.

Its effects on the healing process appear like those of the more active inflammation. Union may be destroyed, or its bond weakened by degeneration and lengthened; or granulations may became œdematous, or in some cases shrunken; and in place of pus, thin serous-looking fluid is discharged; or, new cuticle may be cast off. Commonly, the swelling that attends this form of inflammation is less than that with the sthenic type; the pain, also, is less; the redness, if any be in view, is duller and more dusky, and with a more defined border. Generally, too, the constitutional disturbance, in each case, corresponds with the type of local inflammation; in the one having the characters of acute fever, in the other those of low fever or of mere want of power.

It is of much importance to distinguish these two forms of inflammation of wounds or wounded parts, because of the different treatment which they, severally, require. The signs enumerated above will generally suffice; especially, the observance of the earlier or later time of the setting-in of the inflammation, which is best indicated by the beginning of pain and the acceleration of pulse. If the inflammation be active and sthenic, and perilous to the part affected or to life, active antiphlogistic treatment should be immediately adopted, and should include bleeding, either local or general, according to the condition of the patient and the importance of the seat of injury. Moist soft applications to the part are most suitable; and if the heat be great, ice, or cold irrigation, may be used with good effect. In the opposite type of inflammation, the remedies must be of an opposite kind; wine and bark are the best among them; and for local applications, warm poultices, or such as will best maintain the heat and pliancy of the affected part. Where the diagnosis of the character of the inflammation is sufficiently doubtful to justify an experimental treatment, it is best to give wine and good food, and watch their effects; for inflammations that will be benefited by these are far more numerous than those of the opposite type, and an error with these will be less mischievous than one in the opposite direction.

Another form of inflammation, not unfrequent in and about wounds that are or should be healing, is more chronic than either of these. The granulations (for it is not observable with the speedier modes of healing) become pale, firm, œdematous; and the adjacent structures feel lumpy, heavy, firm, and consolidated, as if infiltrated with half-organised matter. Such a state occurs oftener in the healing of amputation-wounds than in any other cases; and, if the healing be not far advanced, may be dangerous through the usually coincident softening and degeneration of the proper textures of the part, and, among them, of the arteries. Less dangerously, it destroys the natural mobility of parts, and is associated with tardy and insecure healing.

Chronic inflammation, such as this, appears to be chiefly a local fault; at any rate, it is not generally associated with any evident constitutional error, and it usually ceases as the patient recovers power. Its effects may be remedied with stimulant applications, friction, and pressure. The ceratum hydrargyri compositum appears to be a very useful application.

Morbid states of granulations. The analogies between a granulating wound and an ulcer are so many and close, that, as may well be expected, all the varieties of the one condition may be occasionally found in the other. Thus, as ulcers, so granulating wounds, may be irritable, hæmorrhagic, painful, callous, imitating the several characters of ulcers indicated by these names. In like manner, they may, at any time, become affected with gangrene, or with phagedænic or sloughing ulceration. But the pathology of these states is identical with that of the cases in which they have their origin not in wounds, but in diseases or in other accidents; it is therefore referred to the essays on ULCERS and GANGRENE. Moreover, a granulating wound, especially in its advanced stages, may become the seat of a specific disease, *e. g.* of scrofula, syphilis, scurvy, or cancer, and may assume the form of ulceration or other change characteristic of any of these diseases (see SCROFULA, &c.). Thus, through its whole course, a wounded part appears to be a structure in which morbid conditions of the blood are peculiarly prone to manifest or localise themselves. If measles or some other exanthem should make its eruption after an operation, the thickest of the eruption will be at and about the wound; similarly, the general malady of erysipelas may have its local manifestation chiefly or alone at a wound; and scrofula or syphilis, which may previously have been latent, *i. e.* without any local evidence of their existence, may find at a wound a place more fit for their manifestation than any sound or unhurt structure. When healing is complete, this aptness for specific disease in great measure ceases; for numerous as are the diseases of scars, few of them are of specific kind, and it is probable that contusions are followed much more frequently than are wounds by the growth of tumours, and these of more various kinds.

Such are the chief defects and diseases of the healing process; and, before leaving the subject, it may be well to enumerate certain causes of them, often unsuspected, but for which it is advisable to look in any case of which the origin is obscure. Some of these causes are local, namely, the presence of foreign bodies, sloughs, dead bone, collections of pus, hidden blood-clots, surrounding scars: others are general, namely, abiding chronic disease, especially of the kidneys or intestines, mental agitation or depression, bad air, especially that of hospitals long lived in, bad food, the obscure invalid state of habitual slight intemperance.

The morbid conditions of scars after wounds may be arranged as defective, painful, excessive, ulcerative, cancerous.

The *simplest defect of a scar* is that in which it remains thin, weak, vascular, moist, easily 'breaking out,' *i. e.* cracking and yielding so as to expose the subjacent structures. It indicates a failure or incompleteness in the last stages of healing, a deficient development of cuticle, and too little contraction of the granulations or bond of adhesion. Such scars are most frequent after wounds healed by granulations that have become œdematous, soft and puffy, whether through disease, or through their being constricted by the contracting tissues healing round them. They are, therefore, most frequent after wounds that heal most slowly, and in weakly patients. To avoid such scars is one of the uses of cauterising exuberant and œdematous granulations with nitrate of silver or sulphate of copper, and of dressing them with solutions of those or other astringent salts. Similar solutions are useful for the scars themselves, so are those of bichloride of mercury in spirit; and, since they are very apt to be cold, they should always be warmly and drily covered. And, often, this care of them must be taken for many months, since not less time is requisite for perfecting, not these defective scars alone, but those which form in the most favourable manner.

Painful scars are most common after amputations, and have been often described in irritable or painful stumps. But the same affection may occur in the scar of any wound, and with the same obscurity of cause. In some stumps, it is nearly certain that the pain is due to a morbid condition of the ends of one or more of the divided nerves; not, indeed, to the formation of a bulbous swelling, for that is a general occurrence in the healing of nerves, and is commonly painless; but to the morbid adhesion of the nerves to the end of the bone, or to the skin, so that they are kept in constant irritation or inflamed. But in many more painful stumps, no such condition can be found, and they can only be called neuralgic. So it is with other scars; and the cause of the pain is the more obscure through its commencing, in some cases, a long time (it may be years) after the healing of the wound, and without visible change in the scar.

When it is likely that the pain of a scar, in a stump or elsewhere, depends on adhesion, or other such morbid condition of the nerves, the subcutaneous division lately recommended by Mr. Hancock is a very promising means of remedy. In some cases in which a particular nerve is very sensitive to the touch, though it may have no apparent morbid structure or relations, it is proper to divide or remove a portion of it. But when these measures fail, or when the case belongs to the more obscure and severe neuralgia, there remains little more than the often unsatisfactory treatments of the neuralgic affections whose cause is unknown, such as those with large doses of quinine, or of ammonia, or belladonna, or other narcotics. In the less severe cases, the local application of narcotics is commonly sufficient.

Excess of scar-formation presents various forms, if it be studied in its frequent combinations with their indurations and degeneracies. In its simplest condition it appears only as a thick or lumpy scar, which projects from the surface, instead of being plane or depressed. Such a scar sometimes follows the operation for hare-lip, and here shows its worst quality, in that it is unsightly, and apt to contract long after its formation. Similar scars, with equal inconveniences, are not rare after vertical wounds through eyelids. They cannot always be avoided; for, as the excessive formation of scars after strumous ulcers indicates, they may sometimes be due to constitutional defects; but the hope of avoiding them when their deformity would be important will justify the most scrupulous means for obtaining immediate union of the wound. When they are formed, the best method of reducing them is the repeated application of stimulants or of vesicants, *e. g.* by painting them with blistering fluid, or strong solution of iodine. The lowly organised new structures, of which the scars are composed, appear to be destroyed by the inflammation thus excited and made fit for absorption.

Scars that are thus thick have, often, another fault, in that they adhere too much and too long to the adjacent structures: they fall short of that stage of improvement in which there is a gradual loosening of the tissue which at first unites a scar to the parts beneath or near it. In the natural course of events, the scar which follows a deep wound through many structures is at first continuous and nearly uniform through the whole depth of the wound. If the wound have extended down to bone, and the bone be not amply covered in the healing, the scar will be depressed to the bone and so remain; but if the wound have involved soft parts alone, the scar, though it may be at first depressed, will not remain so, but will be gradually raised, by the formation of fat and connective tissue beneath it, to the level of the surrounding skin. In both cases, however, it is a part of the normal healing process, that the scar should be freed from its adhesions to the parts beneath or about it. Thus, scars that at first adhered to bone, gradually acquire freedom of sliding on it; and in those after lithotomy it becomes at last difficult to distinguish any scar-tissue except in the skin.

The persistence and excess of scar-tissue existing in the failure of this loosening process is often a grave inconvenience, either by its deformity, or by rendering the scars liable to ulceration after injury or any other interference with their nutrition. It is difficult to remedy. The best means are, friction, shampooing, steaming, and, if the scar-tissue be very abundant, stimulants or vesication, as for common thick scars that are not adherent; but all must be used very gently when the scar adheres to bone.

Contraction of scars. Another instance in which scars show excess, if not of material, yet of one of their chief properties or tendencies, is that of their morbid contraction. It is much more frequent in the scars of deep burns than in those of wounds; but may occur in any, and especially in any such as involve strong fasciæ. In some cases, the scar appears only to contract; but in more, it becomes very dense, hard, toughly fibrous, nodular, and lumpy; it usually adheres, also, very closely to the structures near it. The force of the contraction is enormous; enough to depress bone, or to displace parts from their strongest connexions, or to contract them into extreme and most damaging deformities.

The almost certainty of some contraction of the scar of a wound healed by adhesion or granulation, and the possibility that it may be excessive, must be regarded in every surgical wound involving parts in which contraction would be mischievous. The length of a wound must always (if possible) be in that direction in which subsequent shortening will be least important; and it may often be right to make as careful provision against contraction of scars, as against the effects of loss of substance, by plastic operations or by lateral or other incisions. When, as in accidental wounds, no provision can be made, the healing must be carefully watched, and, if possible, some elongating force must be applied in the direction proper to counteract the contraction. Thus, for wounds near joints, if there be tendency to shortening of the scar, it must be slowly overcome by splints, with screws; or, better, with elastic bands or cords, whose tendency to recoil after being stretched may exercise a force more powerful and not less constant than that of the scar. And the long time during which certain scars will continue to contract must not be forgotten. The length of treatment must not be determined by weeks or months; it must be continued as long as any disposition to contract exists. Generally, the elongation may be assisted by frequent application of moist heat, or by shampooing, or other means for softening and causing partial absorption of the scar-tissues.

These same means are often sufficient for the deformities produced by the completed contraction of scars. The special modes of adapting them according to the seats and degrees of deformity are described elsewhere (PLASTIC SURGERY); the general principles to be kept in view are, that scar-tissues can be lengthened only very slowly, and seem rather to adapt themselves by changes of nutrition to the external forces brought to bear on them, than to be merely stretched by them; that, in the natural course of events, in however long a time, the tendency of scars is to soften down to a greater likeness to the natural parts in both structure and relations; that they are (as it is said) of low vital power, *i. e.* apt to waste or ulcerate quickly under pressure, friction, or irritation, and that this quality may be often made good use of in promoting their absorption.

When this lengthening of contracted scars cannot be accomplished, the deformities due to them may often be cured by plastic operations. The chief general rules for such operations are, that if the scar is to be removed, so as to bring healthy structures together for union in its place, no portion whatever of its substance should be left; that if the scar or part of it is to be included in any flap for sliding or transplanting, all the borders and surfaces of such flap intended for union should, if possible, be of healthy structure, and not themselves parts of the scar; that flaps should not be dependent on scar-tissues for their supplies of blood; and that scar-tissues should not be used for the formation of flaps, or relied on for any speedy or sound union.

Cheloid scars. The most excessive growth of scars is that in which they become cheloid, a change observed most frequently in scars after burns, but not after them alone.

A scar may become cheloid, which has shown nothing abnormal in its previous course. After being completely formed, and sometimes even at a great time thereafter, it may begin to grow up, increasing somewhat in all its dimensions, but chiefly in depth, and thence becoming more and more prominent. Usually, it keeps a well-defined, gradually rising, rounded border, and a smooth, level, or slightly convex, or sometimes centrally depressed, surface. Its substance is always tough and firm, and becomes more so as it grows older. At first, it is usually more vascular than even recent healthy scars, and has a florid or purple tint; but, gradually, as it becomes harder, so it also becomes paler, and at length is only slightly pinkish, or scarcely more coloured than the healthy skin.

All these characters of cheloid growths following wounds or other injuries indicate that they are hypertrophied or overgrown scars; and with this agree their shape and interior structure. In shape they are like the scars that precede them, but with coarser outlines, and, if the scar were irregular, with an exaggeration of its projections, or of its extensions into the surrounding parts. On section, they present, to the naked eye, an appearance of closely and irregularly matted bands of white or grayish fibres, making a compact substance, lowly vascular, and thinly covered with cuticle. In the microscope, they show fibrous tissue, which (according to their date) is more or less perfectly developed, but seems always mingled with cell-structures in progress of development, or arrested and degenerate in their incomplete forms.

While cheloid growths of scars are increasing and vascular, they are usually attended with a sensation of heat and irritation; but in their later states they are not more sensitive than common scars. After a long period of growth, they generally cease to enlarge, and rarely surpass half an inch in thickness, or, by more than half an inch in any direction, the extent of the scars in which they grow. In this they differ from the fibrous growths of skin that nearly resemble them, and are of apparently spontaneous origin. They may even decrease after a long-continued growth; and are more than common scars liable to be sore and to ulcerate.

In comparison with the frequency of wounds and scars, cheloid growths are very rare; and there is no certainty respecting the conditions in which they arise. Their occurrence in many scars in the same patient, and, much more, their repeated formation in the scars of wounds made for their removal, prove that they depend on some personal or constitutional peculiarity; but its nature is wholly unknown.

When a cheloid growth is recent or in progress, it may be reduced and perhaps cured by active irritation, or by frequent frictions with strong ointments of the iodide or biniodide of mercury, or by frequent applications of vesicants. But against a perfected cheloid growth all such means are of little or no avail. It may be cut out, but a recurrence in the scar of the operation-wound must be feared, especially if the wound cannot be very closely healed by immediate or adhesive union. However, as recurrence is not constant, the extirpation of cheloid growths may often be a proper measure; for there is no probability that, if the operation be useless, the renewed growth will be worse than that which it has succeeded.

A singular form of cheloid growth (as it seems to be) sometimes follows the boring of the lobules of the ears for earrings. A round-oval fibrous lump forms in the lobule, greatly enlarging it, and enclosing the perforation. It may be so defined as to look like a fibrous tumour; but is probably an excessive growth of the scar-tissue, like those that may occur in the scars of sutures. The remedy is excision of the lobule, and it may need repetition.

Ulcerations of scars are not infrequent in any stage of their existence. A common form occurs in recent scars or granulations. While they are yet thin and soft, round, shallow, thin-edged ulcers form in them, exposing the lately covered surface of the granulations, as if only by the removal of the cuticle that covered them. Such ulcers are most frequent in strumous and other feeble patients, and should be treated with good food, and stimulant or astringent lotions, and with fresh air, for they often seem dependent on the confinement of a patient to a sick-room or ward. Older scars, and those of any age, may be attacked with any form of specific ulceration, but seem not peculiarly liable thereto; or, with defective health, and almost trivial injury, they may be the seats of common ulceration. Many of these cases prove the defective power of maintenance which has been already often mentioned as a character of scars. The same is shown in their readiness to slough after severer injuries and exposure to intense cold; and by the necessity of using active stimulants to procure the healing of many of the ulcers thus formed. Of all scars none are so ready to ulcerate as those that adhere to bones; and the ulceration may happen twenty or more years after their formation. The ulceration of scars is probably connected with some rapid degeneration of their tissues; but what this is is uncertain, except that sometimes a calcareous plate may be found in the scar at the bottom of the ulcer.

Tumours may grow in scars; but they are not more frequent than in many of the natural structures, unless we reckon those that are recurrent and seated in the scars of wounds made for the removal of their predecessors. Even these, however, are usually not in, but near, the scars; and indicate the aptness of the place, rather than of the tissue, where they grow.

Cancer is more frequent in scars; whether as recurrent after the removal of scirrhous cancers (*e. g.* in the breast), or as primary epithelial cancer. The epithelial cancers, to which, under the name of warty growths on scars, attention was first drawn by Mr. Hawkins,* may appear shortly after the healing of a wound; but they are much more commonly found on old scars, even on those of twenty or more years' duration. Especially, they occur on such old scars as have frequently been seats of irritation or violence, and on such as are large and coarsely formed, *e. g.* after burns, gunshot wounds, and chronic ulcers over bones.

The first indication of a scar becoming thus cancerous is, usually, its 'growing up;' that is, it becomes elevated and more or less warty. The change may proceed no further, for warty scars may be found that are not, and do not become, cancerous; and enlargement of the cutaneous papillæ (the essential change of structure in warts) is very common in the scars and adjacent skin after chronic ulcers. Still, when scars become warty, and especially if they are coarsely warty, with vascular, knotted, and grouped large papillæ, bare of cuticle or very thinly covered, the probability is that they are already cancerous, and that the enlarged papillæ are filled with the cells and other structures of epithelial cancer. From this state their ordinary progress is the same as that of the papillary or warty epithelial cancers of apparently spontaneous origin (CANCER). They ulcerate at and from their centres: and as the ulceration extends, so do their borders and bases, invading the surrounding skin and the subjacent textures, as deeply as they have time for. At a late period, similar cancer affects the lymphatics in relation with the primary seat of the disease; and death may ensue.

The epithelial cancer of scars is usually of slow progress, in comparison with that affecting the natural structures, the average duration of which is about four years. Especially, it is slow when, as is most frequent, it is seated on the lower extremities. The only appropriate treatment is complete extermination with caustics or the knife if the disease be in soft parts alone, or amputation far from the seat of disease if these means are likely to be insufficient, or, generally, if the cancer have invaded bone. Such thorough treatment of these cases is certainly often sufficient to prolong life.

JAMES PAGET.

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* *Med.-Chir. Trans.* vol. xix. p. 19.

ANIMAL POISONS.

UNDER the category of poisoned wounds is comprised a series of important lesions, which attack the human species through the medium of some peculiar and specific poison, emanating from a body with which the individual has been placed in contact; a poison, acting on the blood, contaminating the constitution, and developing distinct and special symptoms.

This may be derived from the mineral, vegetable, or animal kingdom: but it is to the latter class only that we shall now direct attention; and in so doing we shall necessarily have to exclude some of the contagious and infectious animal poisons, such as syphilis.

The animal poisons, affecting man through the medium of a wound, may be derived from the following sources: 1st, from the dissection of recently dead bodies: 2dly, from the sting or bite of healthy animals,—such as insects, serpents, &c.: and 3dly, from the bite of, or inoculation by, diseased animals,—such as from the dog, causing hydrophobia, or from the horse, glanders.

I. *Poisoned wounds derived from the dissection of recently dead bodies.*

Wounds from dissection are not ordinarily attended with any peculiar and specific disease; they are commonly followed by those affections which are generally met with in incised and punctured wounds inflicted by clean and innocuous instruments. Thus, any form of wound under certain conditions and circumstances may be attended with absorbent inflammation, attacking the deep as well as the superficial glands; inflammation of the subcutaneous tissues of every possible variety; inflammation of the thecæ and tendinous structures; or their secondary effects, such as suppuration, hectic fever, pyæmia, gangrene, &c. All these accidents and affections need no comment in this place.

But in rare and isolated instances, dissecting-wounds are attended with serious and alarming symptoms, often leading to fatal results. Two forms have been recognised, the *mild*, and the *acute;* these, however, only indicate, that in the one instance the poison is of a mild character, and the constitution sufficiently strong to counteract and withstand its effects; while in the other, the dose of the poison is intense, and, being developed in an over-susceptible individual, of generally feeble power, it is followed by a speedy and fatal termination.

The symptoms in the mild form partake more or less of the ordinary characters of non-specific inflammations, and offer scarcely any noticeable characteristic signs: thus, the local appearances consist in the puncture assuming a defined red aspect, which soon becomes pustular; this bursts, and ends in an unhealthy suppuration: there is surrounding erythema, of an erratic form, and inflammation and pain extending along the forearm and arm to the axilla, ending in enlargement and suppuration of the glands. The constitutional effects consist in febrile disturbance, loss of appetite, diarrhœa, fœtid eructations, breathing, &c. The prognosis and termination are favourable; and the treatment required is to be based upon general principles.

The symptoms of the acute or severe forms are those of a truly specific disease: the local signs commence by the appearance of a small circular or oval vesicle over the seat of puncture, which soon becomes turbid, milky, and pustular, and not unfrequently has a defined margin resembling somewhat that of smallpox: this is generally unattended with pain; but the patient often complains of intense pain in the shoulder and about the axilla, which shoots down the chest. The glands in the axilla are early affected, and seem to act as barriers to the further progress of the poison; they become enlarged, and the surrounding cellular tissue is implicated, with serous effusion; there is erythema and puffy swelling. These extend to the subscapular and pectoral regions, spreading down the side of the chest, yielding to pressure, and imparting a peculiar and spongy feel. There is, besides, an œdematous and doughy condition of the arm and forearm, owing to serous exudation into the cellular tissue, and seldom if ever passing into suppuration.*

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* The local symptoms are well exemplified in the case of Professor Dease (*Dublin Hosp. Rep.* vol. iii.). "His demonstration took place on a recent subject, and he awoke early the ensuing morning with severe rigors, sickness, and acute pain in the left shoulder. On the next day, a fulness was observed above the clavicle, along the left side of the neck, which could not bear the slightest pressure. On the day succeeding, a colourless swelling was noticed about the axilla, which first suggested the real nature of the complaint; and on examining the hand, there was found by Dr. Colles the mark of a slight scratch with a superincumbent vesicle. He appeared to

The constitutional symptoms are at first those of strong excitement; but these are soon followed by those of extreme depression of spirits, and much suffering. Rigors, headache, prostration of strength, vomiting, &c. supervene; and lastly, all the symptoms of low typhoid fever rapidly set in. In the case of Dr. Pett, quoted by Travers, on *Constitutional Irritation*, the symptoms on the third day were "a haggard and depressed countenance; violent shiverings, followed by some degree of heat; extreme alteration in appearance; countenance suffused with redness; the eyes hollow and ferrety; some difficulty of breathing, which was sudden, irregular, and amounting almost to sighing; excessive torpor, and the whole aspect resembling one who had taken an over-dose of opium: on the following day there was extreme exhaustion and feebleness, and death ensued on the fifth day."

There are several deviations from the foregoing description: thus, in some cases, the poison may enter the system without involving the absorbent glands; in others, death may ensue from precursory fever, before the appearance of any severe local disease, as in the case of Mr. Ellcock.* Again, the symptoms may be attended with diffused suppuration and pyæmia; in some, gangrene, or sloughing of the integuments and cellular tissue, may ensue. These circumstances depend for the most part on the acuteness and strength of the local action, and the previous habits and condition of the patient.

The diseases with which this affection is liable to be confounded are acute rheumatism and absorbent inflammation; but the history of the case, the peculiar pustular eruption, the blush and effusion over the pectoral region, which is so frequently present, the low

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improve a little for a day or two, though full, florid, and crimson erythema occupied the side in the region of the pectoral muscle, extending downwards. On the morning of the sixth day he showed symptoms of delirium; and a vesicle appeared on his forearm, which remained stationary to the last. By the next day the erythematous swelling had extended over the entire side of the body, from a little below the axilla to the hip; and the swollen part became studded pretty thickly with indurated papulæ; the delirium was more confirmed. On the eighth day the inflammation completely involved the axilla, and on its posterior edge an abscess seemed to have formed, though there was no fluctuation. At this period the opposite or right arm exhibited an intumescence on its anterior part, occupying about a hand's-breadth of the flexor muscles, which was punctured on the same evening and discharged about a teaspoonful of serous fluid, but without relief; and within an hour or two afterwards, being the eighth day from the accession of the disease, he expired."

* Travers *on Constitutional Irritation.*

typhoid fever and rapidly fatal termination, will assist us in recognising the disorder.

The prognosis is generally unfavourable; and it is affirmed by Travers that one only in seven recovers. When death does not take place immediately, large sloughs and purulent depots render the recovery tedious and protracted, taxing the patient's constitution to its utmost.

The morbid appearances include the different grades of diffuse cellular inflammation, and the morbid effects of poisoned blood.

Respecting the pathology various opinions have been expressed. Some attribute the disease to an irritation and inflammation of a simple kind, affecting a constitution and idiosyncrasy of peculiar excitement; others, to the absorption and irritation of a putrescent fluid, as suggested by Majendie; but this explanation will hardly account for the frequency of the disease after contact with recent bodies before putrefaction has set in: again, others consider it to be a specific virus, acting primarily on the blood and rapidly involving the nervous system, its effects mainly depending upon the quality of the poison and the susceptibility of the individual. The arguments brought forward in favour of this view are the following: the plurality of persons affected at the same time, from the same body and with the same symptoms;* its frequency after dissecting recent subjects, and more especially subjects who have died of acute disease, such as puerperal fever, peritonitis, &c.; its occasional occurrence without any local affection whatever; and, lastly, although rarely, its existence without wound or abrasion.

Treatment. Local applications, if used at all, must be employed immediately, decisively, and effectually. Should a person be in bad health at the time of receiving a prick or wound during dissection, no matter what condition the subject be in, it behoves him to pay immediate attention to the injury, and anticipate any further consequences; but should the wound be received whilst engaged on a recent subject, and one which had died from acute disease, much more caution and attention is required, even if he be in the best of health. The part should be well cleansed, and a temporary ligature applied immediately above the wound; then the bleeding, if any, should be encouraged to flow freely; where there is no bleeding, suction must be employed. After such preliminaries, caustics are to be applied freely to the punctured wound, which may be enlarged if necessary; the nitric and sulphuric acids, nitrate of silver and chloride of zinc, are generally recommended. Directly there is any irritation or inflammation in the site of the wound, a free incision must at once be made, and bleeding encouraged; and should there be a tendency to erythematous extension, a circular line may be made around the part with the nitrate of silver, so as to prevent any further spreading. When the disease has fully set in, warm fomentations, and incisions where required, must be had recourse to.

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* See the case of Dr. Cumming, quoted by Dr. Duncan in the *Medico-Chir. Trans. Edinb.* vol. i.

So soon as the constitution begins to suffer, immediate removal to country air is absolutely necessary, and the powers of life must be kept up by tonics, stimulants, sedatives, &c., as the case may require. But fresh air, and good nourishing diet, will do more in combating the effects of the poison than trusting solely to medicinal measures. Calomel and venesection are to be sedulously avoided.

II. *Poisoned wounds from healthy animals; the stings of insects, bites of serpents, &c.*

With regard to poisoned wounds produced by the stings of insects little need be said; these are for the most part attended by mild symptoms, and are remediable by simple topical remedies. In bees and wasps the sting is generally left in the wound, and should be extracted with care, and the after irritation allayed by the application of cold or stimulating lotions, or protection from the air by means of flour, chalk, &c. Sometimes through accident, as in eating fruit, the insect may be swallowed, and in its passage through the fauces may excite a severe and diffused inflammation, which may extend to the glottis and produce impending suffocation; this must be treated promptly by scarifications, leeches, and the ordinary appliances of surgical aid. The scorpion is the only insect recorded to have any virulent poison, but its malignity in Europe is said to be trifling as compared to that which is experienced in Africa and in the East; and even in these countries it is said by some to cause no material injury. The tarantula bite is attended with no dangerous symptom, and will readily heal; the wonderful stories respecting its virulence are unfounded.

Poisoned wounds from the bites of serpents are much more formidable; they are occasioned by a class of serpents termed venomous, which have a special apparatus for secreting a poison at the base of the upper fangs, by which they are enabled to inflict an injury and produce the most serious and dangerous symptoms, in some instances causing speedy death.*

The viper is the only poisonous reptile in England; but in other parts of the world there are several, such as the rattle-snake, the whipcord-snake, the phoorsa-snake of the East Indies, the cobra de capello, &c. Some of these are brought to this country for exhibition, and now and then fatal instances are witnessed of the effects of their bite on man.

The bite of the viper is attended with the mildest form of symptoms, and the effects are seldom, if ever, fatal in this country.

The symptoms generally observed in poisoned wounds by venomous serpents are the following:

Shortly after the bite, there is a pricking burning pain in the wound, which rapidly extends upwards, and becomes very acute. Soon afterwards the part and limb rapidly swell and inflame; these conditions will, however, vary in different individuals, owing to changes taking place in the subcutaneous cellular tissue, and owing to the complication either of the absorbents, veins, or both, of the affected part. Thus, the colour of the limb may assume a dark red appearance, or be merely a pale white; but as the disease advances, a series of abnormal colours are met with, passing from red to pale white, and from pale white to blue, violet, gray, leaden, or marble hue. The swelling again also varies, and will take on the characters of the special affection of the involved structures: thus, we may have in some a diffused inflammation of the cellular tissue; in others a superficial erysipelatous condition; in others, absorbent inflammation; in others, a local phlebitis; and in others, a plastic fibrinous effusion, or an œdematous infiltration, or an effusion of sanguineous material, giving an appearance of ecchymosis. The glands in the axilla are generally enlarged and involved early when the upper extremity is the part wounded, and the glands in the groin when the bite is in the lower extremities. These glands inflame and suppurate, and form sinuses and fistulous openings. The limbs become stiff and difficult to move from infiltration of the cellular tissue between the muscles. Phlyctenæ and bullæ appear on the surface, filled with sanious fluid. The part grows livid and cold, gangrene and sphacelus set in.

The constitutional symptoms are early and rapidly developed. There is general derangement of the nervous system, evinced by great anxiety, depression, and prostration; profuse cold sweats, difficulty of breathing, vomiting, bilious stools, a universal yellowness of the skin, excruciating pain at the navel, and rapid death. In bites from the rattle-snake and the cobra, the local and constitutional symptoms take place nearly simultaneously; the vital principle is from the first exhausted suddenly, as though by a stroke of lightning; the blood ceases to flow in the smaller vessels of the swollen part; the superincumbent skin feels deadly cold; the action of the heart is so weak that the pulse is scarcely perceptible; the stomach so irritable that nothing can be retained on it; dejection and horror overpower the mind, and a low muttering delirium closes the scene. In the case of one of the keepers of the Zoological Gardens, who was bitten on the bridge of the nose by a cobra a few years ago, half-an-hour only had elapsed when he was apparently dying, being unable to speak, swallow, or support himself; the pupils were dilated, face livid, heart's action feeble, and he was scarcely conscious. Death took place in little more than an hour from the infliction of the wound. An interesting case of prolongation of life for nineteen days after the bite of a rattle-snake is recorded in the *Philosophical Transactions* for 1810.

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* For a description of the venomous serpents see APPENDIX.

The prognosis is unfavourable; rapid death is the general result; but, should recovery take place, it will be very protracted, owing to the large amount of surface injured, and the immense call upon nature's power of repair, often overtasking it, and finally leaving the limb useless, either from stiffness of the joints, or adhesion of the muscles in one uniform mass.

The morbid appearances in the bodies of persons dying from serpent-poison have seldom been noticed; it is, however, stated, that there is generally muscular rigidity; the body is more or less swollen and abnormally coloured, at times presenting bullæ and unhealthy ulcers; the head and brain often contain much serum, and there is much increase in the cerebro-spinal fluid; the lungs are dark and congested, and the heart either empty, or filled with much dark blood.

The effects of the poison seem to cause an altered condition of the blood. In bites from the phoorsa-snake, in India, there is noticed a hæmorrhagic tendency during life. In the rapid death from the bite of the cobra, above cited, all the phenomena of asphyxia were present, and death was supposed to have resulted from the poison paralysing the medulla oblongata, and those portions of the nervous system that are instrumental in carrying on respiration, at the same time that the blood was disorganised by the action of the virus.

The treatment, locally, will be the same as that recommended in dissecting-wounds, only it is imperative that it should be adopted at the moment of receiving the bite; the immediate application of a ligature above the wound to prevent absorption, the excision of the bitten part, or the destruction of the poisoned surface by escharotics, are to be employed. The rubbing of the limb sedulously with olive-oil is said to have been successfully had recourse to.

The constitutional measures comprise the following directions: to avoid the use of remedies which tend to increase the fluidity of the blood, such as calomel, alkalies, &c.: to counteract and get rid of the effects of the poison by the action of medicines; of these, numerous so-called specific remedies have been recommended, as adopted by inhabitants of the countries where poisonous serpents abound, viz. guaco, the sacra vitæ ancora; radix corineæ; decoction of the Virginia snake-root; the Tanjore pill, whose chief ingredient is arsenic, &c. The exhibition of stimulants and spirits in large doses, ammonia, &c. has been advocated, and used with beneficial effect, inasmuch as they counteract the great vital prostration. Arsenic has been given in several cases with success, and has been employed in the shape of Fowler's solution in two-drachm doses every half-hour for four successive hours. Iodine also has been used successfully in poisoned wounds from the phoorsa-snake. Olive-oil has been given internally, and much recommended.

Should the patient rally from the immediate effects of the poison, we must keep up the powers and combat the succeeding symptoms by means of tonics and support.

III. *Poisoned wounds derived from diseased animals.*

Of these we shall only allude to two classes, viz. hydrophobia and glanders.

HYDROPHOBIA.

This term signifies the 'dread of water,' and is used to denote a disease in which that symptom forms one of the most prominent, constant, and marked characters.

The name has been objected to in consequence of the occasional absence of this pathognomonic sign, and of its presence in other diseases; hence it has been proposed to substitute the term *rabies* or *rage*, which also constitutes one of its distinguishing features, and *lyssa*, the Greek specific name for the madness of dogs. The disease, however, is generally known in this country as hydrophobia, and we have therefore adopted this term.

Hydrophobia consists essentially in the inoculation of the human body with the saliva of a rabid animal, which produces certain characteristic symptoms, always terminating in speedy death. Before adverting to these symptoms in man, it behoves us to consider well the disease as it affects the dog, from which animal the poison is most frequently derived.

Mr. Youatt's* description has been the one most uniformly accepted and quoted: he says: "The disease manifests itself under two forms: the *furious* form, characterised by augmented activity of the sensorial and locomotive systems, a disposition to bite, and a continued peculiar bark. The animal becomes altered in habits and disposition, has an inclination to lick or carry inedible substances, is restless and snaps in the air, but is still obedient and attached. Soon there is loss of appetite and thirst, the mouth and tongue swollen; the eyes red, dull, and half-closed; the skin of the forehead wrinkled; the coat rough and starring; the gait unsteady and staggering; there is a periodic disposition to bite, the animal in approaching is often quiet and friendly, and then snaps; latterly, there is paralysis of the extremities; the breathing and deglutition become affected by spasms; the external surface irritable, and the sensorial functions increased in activity and perverted; convulsions may occur. These symptoms are paroxysmal, they remit and intermit, and are often excited by sight, hearing, or touch.

"The *sullen form* is characterised by shyness and depression, in which there is no disposition to bite and no fear of fluids. The dog appears to be unusually quiet, is melancholy and has depression of spirits; although he has no fear of water, he does not drink; he makes no attempt to bite, and seems haggard and suspicious, avoiding society and refusing food. The breathing is laboured, and the bark is harsh, rough, and altered in tone; the mouth is open from the dropping of the jaw; the tongue protrudes, and the saliva is constantly flowing. The breathing soon becomes more difficult and laborious; there are tremors and vomiting and convulsions."

Virchow† denies the existence of two distinct forms; he considers these to be merely prolonged states of certain stages of the disease, viz. that the sullen form is the first or melancholic stage, and that the furious is the second or stage of irritation. He describes the disease in dogs as consisting of three stages, and in the following manner: the first stage is the *melancholic*, and is often unnoticed and unrecognised at its onset; still there may be observed a palpable change in the natural condition, alternations of depression and exaltation, restlessness and change of place, sudden waking from sleep, irritability, deranged digestion, anorexia. The dog has often a greedy appetite, but sometimes leaves his food or snaps at it; there is natural thirst and no fear of water. After these premonitory symptoms have set in, the specific character soon becomes developed; there is great susceptibility in the cicatrix, when a bite or wound has been the antecedent, a change of affection, character, and desires, a proneness to lap his own urine, and eat the fæces of other dogs; a peculiar idiosyncrasy to take all sorts of unwholesome and indigestible things, such as straw, paper, wood, &c.; there is much sexual excitement, and eager licking of the genitals of other dogs; he seems friendly with the cat, but exhibits a marked change of affection towards his master; he becomes shy and backward and avoids observation. The organs of deglutition and respiration become involved; there are spasms and difficulty in swallowing, as if something was sticking in the throat; alteration in the voice; arrest of salivary secretion; application of the tongue to cold surfaces, such as stone, iron, &c. Changes also take place in the motor system, for in all there is more or less debility and weakness.

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* Youatt *on Canine Madness.*

† Virchow, *Handbuch der Pathologie u. Therapie,* Band ii. Abth. i. p. 344.

The second stage is the irritable and *furious*. It commences generally in from one to three days, but may set in after twelve hours; it is seldom, however, met with after the eighth day. This irritation, the height of the disease, is not always uniform in its course; the paroxysms are strongest and longest at the onset, commencing with restlessness and irritability; he runs out of the house, attempts to bite, goes from place to place without thought or reason, endeavours to break his chain or destroy his kennel, and on his inability to do so increases in rage, and if he gets loose will run great distances. It is this proneness to bite which renders this period so dangerous. The paroxysms may last several hours, and often even a whole day; then follows a remission which is very deceptive, as all the signs of disturbance subside; but the dog, aware of his unsociability, generally hides. The disease is very often described from dogs who have been hunted, hooted, and followed about in the streets and goaded on to madness, and in these severe symptoms are superadded, such as panting and flow of saliva, outstretching of the tongue, thirst, dread of water, thrusting of the tail between the legs, starting of the hairs, &c. &c. The chief and prominent symptoms of this stage consist in psychical and æsthetic changes; there is a kind of acute mania and delirium, disobedience, no knowledge of his master, no avoidance of danger, sudden anger and snappishness, outbursts of wildness, loss of general sensation and all sexual feeling. The changes in respiration and deglutition are, altered tone of voice, between barking and howling, indicative of extreme distress, swelling of the fauces, tongue, and nose. The movements of the body are rash and hasty, and the heart's impulse strong. The duration of this stage varies; it generally lasts three or four days, passing into the next and final stage; but in rare instances it may terminate suddenly in death, through a form of apoplexy.

The third stage is the *paralytic.* The paroxysms now become weaker and remittent, the animal emaciates rapidly, the coat falls off, the flanks sink in, the hind extremities are weak and lame, he lies on one side in great prostration, but when roused is still snappish and bites; if able to walk, he totters and drags himself along; the eyes are sunken and dull, the mouth open and dry, the tongue hanging out and hard, the heart's action weak, irregular, and intermittent, the breathing oppressed; convulsions may occur. Death takes place from exhaustion, or during a paroxysm, in from five to eight days from the first attack.

The disease has been noticed in the cat,* horse,† wolf, and other animals; and these, when so attacked, are capable of communicating the disease to man.

We will now describe the symptoms of the disease in man, and we shall find some of them analogous to those of the dog, and some differing in several points. Thus, in man, there is excessive hyperæsthesia, frightful convulsions, and fear of water; also greater difficulty in swallowing, owing probably to the more difficult mechanical conditions of the act in man.

After the bite from a rabid animal, there is generally an absence of all immediate symptoms, so that the patient is thrown entirely off his guard and takes no further notice of the matter; the wound heals, and he pursues his ordinary avocation; but usually in the course of about six or seven weeks the first intimation of the disease shows itself. This period of latency varies considerably, according to certain conditions which will presently be referred to.

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* See, in the *Transactions of the Medical Society of London,* the case of a young lady who died in seventy-four hours from hydrophobia caused by the bite of a rabid domestic cat.

† Youatt *on the Horse.* He describes this disease in the horse with his usual accuracy, and cautions the attendants on the communicability of the disease, as instances of death have resulted therefrom owing to carelessness.

The premonitory symptoms which usher in the complaint comprise general and special manifestations; these constitute the melancholic stage of Virchow. The general symptoms are those commonly met with in other diseases, consisting of ordinary pyrexia, a feeling of being unwell, uneasiness and restlessness, loss of appetite, alternate chills and flushes, sore throat, and stiffness about the neck, often attributed to cold; then actual febrile symptoms set in, with nausea, vomiting, headache, and excitement. But soon, or even without any of the above symptoms, the peculiar and special characters become manifest, which generally last two or more days, and then speedily run on to the second stage. There is an irritation in the cicatrix of the bite, an itching and painful sensation, often regarded as neuralgic; this increases, and sometimes extends along the course of the nerve. The cicatrix becomes red, swollen, and inflamed, and often ulcerates, discharging a thin unhealthy pus. The accompanying pain often takes on the character of chronic rheumatism, and shoots upwards towards the præcordia. The psychical and æsthetic changes consist in altered actions and affections; the patients become quieter; if children, they are more shy; if older people, they are depressed, lonely, and anxious, with a certain degree of listlessness, passing into a vacant stare, regardless of surrounding objects, a kind of melancholy; there is anxiety respecting the bite, making much inquiry, and anticipating danger. Many, however, are unusually irritable and ill-tempered. There ensues a characteristic anxiety, attended with pain in the præcordia and sense of weight and pressure upon the chest; there is disturbed and broken sleep, the patient suddenly starting up in frightful dreams; often sinking back into mental depression, and becoming apprehensive and gloomy. The generative organs are sometimes excited, inducing priapism and seminal ejections. There is loss of appetite and no desire for swallowing; a feeling of clamminess; sighing and oppression of breathing, with unusually deep inspirations; the voice is rough. There is a sense of languor and lassitude, great weakness and heaviness; sometimes slight convulsive twitchings about the face and extremities: the heart's action is strong.

The second or actually specific stage is that of irritation; hydrophobia being its chief character. It generally follows after the premonitory stage, but in some cases it may become developed at once, so rapid and sudden as to take place without any preliminary manifestation. It is ushered in with stiffness of the muscles of the throat, jaw, and root of the tongue, pains in the epigastrium and diaphragm, chilliness and drowsiness. Next there is hyperæsthesia of the eighth pair of cerebral nerves, as evinced by the convulsive spasms of the muscles of deglutition, rendering all attempts at swallowing difficult, and causing severe paroxysms,* hence the great dread of solids and fluids, and the subsequent dryness of the mouth and throat with distressing burning thirst, which cannot be quenched; the spasm extends to the muscles of the larynx, inducing hurried respiration, and a sense of suffocation; the voice is changed and hoarse; the secretions of the mouth and fauces, which were at first frothy, become now viscid, and can only be expelled with difficulty, causing a hawking and barking noise in the effort; the convulsive spasms afterwards involve the muscles of the general system through the spinal and cerebral nerves, inducing convulsions which may resemble epilepsy and tetanus, and may last from ten to twenty minutes. There is flatulency, and vomiting of a dark-greenish bilious fluid; the micturition is frequent, and in later stages the urine is passed involuntarily. The senses are rendered morbidly acute, the surface of the body irritable, and readily acted upon by the slightest gust of air, or even the feeling of the pulse, as inducing an accession of the convulsive paroxysm; the sight or sound of fluids cannot be borne, as aggravating the attacks; sometimes even the smell of particular things will do so. The mind becomes in a state of frightful agitation, anxiety, and alarm; there is a fear of even their best friends and of being left alone; there is no comfort or consolation, but indescribable despair, with sometimes entire loss of control, exciting rage. There is no sleep, and the patient is often talkative and verbose. The mental disturbance may be very slight, but, on the other hand, attended with temporary rabid impulses and delusions, sometimes causing an inclination to bite. The features possess a wild sparkling appearance; the brows contracted, the eyes staring, the angles of the mouth retracted, and an intensely anxious and haggard aspect. As the disease progresses, the paroxysms increase both in frequency and violence, and are oftentimes attended with great cerebral excitement, bordering upon wild maniacal fury. The duration of this stage may last from twenty-four to forty-eight hours; it is generally short and severe.

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* Dr. Marcet gives the following graphic description of hydrophobia, which may be taken as the standard, although not constant, condition: "On our proposing to him to drink, he started up and recovered his breath by a deep convulsive inspiration; yet he expressed much regret that he could not drink, as he conceived it would give him great relief, his mouth being extremely parched and clammy. On being urged to try, however, he took up a cup of water in one hand and a teaspoon in the other. The thought of drinking out of the cup seemed to him intolerable; but he seemed determined to drink with the spoon. With an expression of terror, yet with great resolution, he filled the spoon and proceeded to carry it to the lips; but before it reached his mouth, his courage forsook him, and he was forced to desist. He repeatedly renewed the attempt, but with no more success. His arm became rigid and immovable whenever he tried to raise it towards his mouth, and he struggled in vain against the spasmodic resistance. At last, shutting his eyes, and with a kind of convulsive effort, he suddenly threw into his mouth a few drops of the fluid, which he actually swallowed. But at the same instant he jumped up from his chair and flew to the end of the room panting for breath, and in a state of indescribable terror."—*Med.-Chir. Trans.* vol. i. p. 158.

The third or paralytic stage is the decline and last moments of the disease; it is attended with rapid depression and nervous exhaustion, intermission of the paroxysms, incoherency, and delirium; there is great emaciation; the mouth remains open, and the saliva runs out, or else passes back into the throat, causing a gurgling noise, and the urgent attempt to swallow it or spit it out induces a choking sensation. The pulse becomes small, quick, and irregular; the skin bedewed with clammy sweat; the eyes dull and sunken, and the pupils large; and death takes place either from asphyxia, during one of the convulsive attacks, or from exhaustion. The patient, however, may die quietly, sinking into a state of repose, with abatement of all the symptoms; in one case* being able to eat and drink, and expiring immediately on suddenly waking.

The duration of the disease throughout its whole course varies from seventy-four hours to six or seven days: death generally occurs on the second, third, or fourth day; it has been fatal in sixteen hours, and examples have been recorded where it lasted two or three weeks.

As regards the diagnosis, there is no one particular symptom which can be relied upon as forming a distinguishing mark of this disease; the symptoms must be taken collectively, and then there is no disease simulating it: thus, the peculiar combination of disturbance of the muscles of the pharynx and larynx, the psychical hyperæsthesia and fear, the altered voice, the difficult breathing and swallowing, the perverted appetite, the hallucinations, and the easily excited rage, are for the most part the diagnostic signs. The dread of water, the almost characteristic symptom in man, is not always present, as may be proved in recorded cases. On the other hand, this symptom may be met with in other diseases: thus in hysteria†

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[*] *Lond. Med. Repos.* vol. xviii. p. 296; case quoted by Mr. Dendy.

[†] Dr. Mason Good relates the case of a young lady of nineteen years of

we may have what is called hysterical hydrophobia, where the sight of water induces a paroxysm of hysteria, but this only lasts a short time; in inflammatory affections about the throat, larynx, and neck, and in certain diseases of the brain, there may be a difficulty and dread in swallowing fluids, which is called symptomatic hydrophobia; in hypochondriasis and melancholia there is sometimes painful and convulsive deglutition. The mental distress so characteristic of hydrophobia may also be observed in severe forms of hysteria, associated with high nervous excitement; Dr. Copland cites three instances in his article on Rabies in the *Dictionary of Medicine.* It resembles tetanus in many of its symptoms, as well as in its rapid progress and fatal termination; also in its most frequent cause, a wound or puncture of the surface of the body; but the distinction between the two is well marked, and has been adverted to in treating of TETANUS.

Post-mortem appearances. As in tetanus, there is no distinct lesion to be found, otherwise than the ordinary appearances met with in persons dying from asphyxia and exhaustion. In general, there is early stiffness of the body and early decomposition. The brain and membranes are congested, and occasionally there is serous effusion; but no abnormal changes are detected. The medulla oblongata, spinal cord, and its membranes present no visible lesions otherwise than congestion. Dr. Copland, however, remarks, "that the absence of all lesion in these parts has not been satisfactorily shown; and whether the existing lesion be one of an inflammatory character, or one interesting the intimate structure of these parts in such a manner as to escape the detection of our unassisted senses, there are strong reasons for inferring that some change actually exists in these situations, though it may not be limited to them, but may extend to the related and associated nerves, and even to the parts supplied from these sources and by these nerves."*

The nerves at the seat of injury or bite have been found inflamed, but not always so, and sometimes presenting a peculiar

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age, of a highly nervous temperament, who had hydrophobia or "water-dread" which had no connexion with rabies, and was preceded by a very severe toothache and catarrh. The muscles of the throat had no constriction except on the approach of liquids, and the patient through the whole disease, which lasted a week, was able to swallow solids without difficulty; but the moment any kind of liquid was brought to her, a strong spastic action took place, and all the muscles about the throat were violently convulsed if she attempted to swallow. Op. infr. cit. p. 273.

* See article "Rabies" in Copland's *Dictionary of Medicine.*

redness. The eighth pair of cerebral nerves and the cervical sympathetic have been said to be pinkish.

The fauces, pharynx, and œsophagus are found reddened and injected, from vascular excitement; sometimes coated with lymph; but in other instances no change whatever existed.

The salivary glands are sometimes normal, and at other times enlarged and vascular.

The larynx, trachea, and lungs have their lining membrane injected and congested; and there is a viscid frothy mucus in the tubes.

The heart and pericardium are either normal, or present evidences of death from asphyxia.

The blood is black and fluid, infiltrating the tissues, and sometimes grumous: Ragsky has analysed it, and found in 1000 parts—769·6 water, 4·8 fibrine, 133·0 blood-corpuscles, 80·2 albumen, 12·4 extractive matter and salts.

Pathology and nature of the disease and its causes. Much discrepancy of opinion exists as to the seat and nature of the disease, inasmuch as the absence of physical changes gives rise to numerous speculations.

There is a great analogy to the more virulent poisoned wounds, such as the poison of venomous serpents, the severe form of dissecting-wounds, and the acute form of glanders; but each of these forms has its peculiar action and appropriate symptoms. So again vegetable and mineral poisons have their special action; thus, alcohol affects the brain, strychnia the medulla oblongata, &c. Hydrophobia or rabies is considered by many to be a peculiar and specific poison, a kind of ferment, acting on the nervous system, and inducing hyperæsthesia of the medulla oblongata and neighbouring nerves.

Dr. Copland remarks, that "the history, progress, and character of this affection is essentially that of a nervous malady of the most intense form, involving the medulla oblongata and pneumogastric nerves: it is not imbibed by the capillaries and carried into the circulation, as evinced by its latent protracted period; it is not absorbed by the lymphatics, as there is absence of all glandular irritation."

Maugor describes the disease to be a continued fever; Rust and many others consider it to be an inflammatory affection. Some believe the sanguiferous system to be the seat of disturbance, but whether this disturbance is produced by changes in the blood has not been proved.

Some, again, consider the disease as being only symptomatic, and that the true disease is of another kind: thus Ruychner ascribed the sullen rabies to a urinary affection; Pring and Heussinger to a form of carbuncle.

Some regard it as a form of tetanus, and deny its contagious character; but neither of these opinions has any support.

Sir Isaac Pennington and others have actually denied its existence, and attribute the symptoms and effects to imagination.

Dr. Marochetti, in 1820, observed the formation of vesicles or pustules under the tongue; and this observation was confirmed in 1822 by M. Magistel in France. Two species of pustules are described, the crystalline and the opaque: the former, projecting, rounded, and of the size of hempseed, transparent, and containing a limpid serous fluid; the latter, flattened, of a circular form, of the size of a lentil, and without transparency. The crystalline appear early in the latent stage, and not in all the persons who are bitten; the opaque are observed at a more advanced period, and all persons bitten exhibit them.

The primary and essentially exciting cause of the disease is a peculiar poison generated or contained in the saliva or secretion from the mouth of the rabid animal, conveyed by the teeth or lips, and so inoculating the individual. It is not requisite that there should be an actual bite, but there must be an abraded surface. Trolliet* maintained that the poisonous agent is not the saliva *per se*, but the frothy matter driven out from the bronchi and mixed with the saliva. From experiments it is proved that neither the blood, flesh, milk, seminal fluid, nor the breath, nor the secretions and excretions of the abdominal viscera, are capable of producing hydrophobia, although Majendie has endeavoured to prove that the blood is contagious.

Respecting the nature of the poison, Dr. Copland asks, "Does it consist in a material, organised, or chemical change in the secretion constituting the virus; or is the secretion merely the vehicle of a nervous aura or emanation which is actually the infecting agent, and which is retained in its vehicle for only a short period?" The first of these opinions is the one generally adopted.

As regards the activity of the poison, it is more volatile and less active than many other morbid poisons; hence all that are bitten do not suffer; thus, Hunter gives an instance in which, out of twenty persons bitten by the same dog, only one received the disease. Faber states that at Würtemberg, of 145 persons bitten, 28 only were attacked. It is generally calculated that of those who are exposed to the venom about one in four matures the complaint, and the rest escape.

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* *Traité de la Rage.*

The virus is capable of propagation from the human subject to any animal by inoculation, but there is no example of transmission of the poison from man to man. MM. Majendie and Breschet collected upon a piece of linen a portion of the saliva of a rabid man in the last stage of the disease, and inserted it under the skin of two healthy dogs, one of which became rabid and bit two other dogs; of these latter one also fell a victim to the disease just a month afterwards.

The period of incubation or latency is generally long, seldom less than 40 days; however, the disease may occur as early as the 7th or 8th day; and again, it may not manifest itself until the 7th or 9th month; in some rare instances it has been stated to have been developed as long as 12 years after the bite. Trolliet gives the following summary of 23 persons who were bitten by a mad wolf in the space of 9 hours, and of whom 13 died: of these latter, in 6 the disease appeared between the 15th and 30th day, in 4 between the 30th and 40th day, in 2 between the 40th and 53d day, and in 1 in 3 months and 18 days.

The predisposing causes require but little comment. Every sex and age, without discrimination, are liable to its attack; even the infant at the breast has been the subject of hydrophobia. Respecting the constitution and habits, there is no temperament, no strength nor weakness of body, proof against the disease: no mode of life or class of society make any difference; it invades alike the rich and the poor, the well-fed, without anxiety or trouble, and the poverty-stricken and hard-working person.

Of its frequency in particular countries, or its geographical distribution, the popular notion is, that great heat and cold induce the disease: but this is fallacious; for those most exempt are the inhabitants of Greenland, Kamschatka, Sweden, Denmark; and this is asserted to be the case also with the inhabitants of the tropics, the south coast of Europe along the Mediterranean, the whole of Africa, South Asia, and America. However, this latter assertion is not actually correct; for although it was stated by Alpinus, Larrey, and others, to be unknown in Egypt, yet Pruner, in 1847, found not only the disease, but that it was well known to the Koptic tribes; Guyon found it in Algiers, Johnson in the East Indies, Rust in North America, and many others have observed it in the West Indies, South America, Mexico, &c. Dr. Morehead found it in

Bombay to bear the same ratio to population as in England, and to be equally fatal.

It appears to prevail, not so much in relation to the climate as to the presence of animals capable of generating the disease, and thereby transmitting it to man. Thus, in former years in Prussia, when there were numerous wolves infesting the forests, the disease was very prevalent, for from 1810 to 1819 inclusive there were 1635 deaths. And again, the accounts seem to refer the disease rather to transmission than to spontaneous development; thus, Mosely states that before 1783 it was not known in all the West India Islands for fifty years, when in the spring of that year it broke out at Hispaniola, and in June at Jamaica, and remained until March 1784, and that it was stated to have been imported into Jamaica. In the Mauritius it was unknown until 1821, when it was introduced by an English ship from Bengal, and it became developed to a great extent. In the great epizootic of 1852 in Northern Germany, in Hamburg alone there were 267 mad dogs, whilst at Elbisland, during the same period, there were no instances. It is stated to be rare in England, and Dr. Willan remarks that in his time only one instance occurred during five years in London. At Edinburgh in 1824 not a single case had occurred during twenty-five years. The mortality from this disease in England, as stated by the Registrar-General's returns, was, during the ten years from 1847 to 1856, 128 cases, of which 101 were males, and 27 females.

The disease occurs pretty uniformly through every season of the year and every range of temperature; it has appeared under every variety of meteorological changes, and the association of dog-madness with the dog-star is incorrect. Faber, in his statistics at Würtemberg, found it most frequent in the months of March, February, June, and January, and least prevalent in September, October, and August. Trolliet, however, from his statistics, shows that most cases occur in February, May, July, September, and October.

The excitement of vehement rage has been looked upon as a predisposing cause, inasmuch as most animals, when roused to a high degree of rage, inflict a wound of a much more irritable kind. It has been thought that rage has a peculiar influence on the salivary glands, and excites the secretion of an acrimonious virus; but the symptoms induced thereby are not those of hydrophobia, although of a highly nervous character.

The eating of putrid food cannot be regarded as a cause, for this is the ordinary state in which dogs and cats obtain the offal, to which they show no disgust.

Long-continued thirst, from want of water to quench it, has been suggested as a cause; but in long voyages, when reduced to short provisions, dogs have died of thirst and hunger without any signs of hydrophobia. Experiments have been instituted respecting this point: one dog was fed with salted meats and totally restrained from drinking, a second was allowed nothing but water, and a third allowed neither meat nor water; the first died on the forty-first day, the second on the thirty-third day, and the third on the twenty-fifth day, not one of them evincing the slightest symptom of the disease.

The treatment will comprise, firstly, the immediate, or that employed at the time of the bite, which may be termed the preventive or prophylactic. This is to be managed in the same way as is adopted in all other poisoned wounds, viz. by immediately destroying the injured part by powerful escharotics, which are to be unsparingly used to the whole surface and entire depth of the bite. Mr. Youatt states that he has employed lunar caustic to upwards of 400 persons, and four times on himself, after bites from dogs decidedly rabid, and he has not seen the disease appear in one instance. Any of the escharotics are serviceable; some prefer the caustic alkalies, others nitric acid, sulphuric acid, arsenical paste, chloride of zinc, actual cautery, boiling oil, &c.

Complete excision, and even amputation of the part, has been had recourse to, and with success; but excision is preferable, and is often performed on the spot, at the moment of the infliction of the bite, in the absence of escharotics. Ligature around the part above the bite is only serviceable for a time, while the proper means of treatment are being procured.

During the stage of incubation, or the latent period, where the bite has been allowed to pass by unnoticed, and where the patient commences to feel anxious about it, seeking advice, then we must still adopt the same measures as above, and endeavour to destroy the latent poison, which by many authorities is considered still to reside in the situation of the bite, by resorting to excision. It is also recommended to ascertain if there be any vesicles or pustules under the tongue, as affirmed by Marochetti; and if present, these are to be opened and cauterised. We must adopt, at the same time, a psychical treatment, by holding out the greatest hopes to the patient, and dwelling on the probable prospect of cure, and never allowing any depression of mind. Stimulants and antispasmodics may be given, as also anodynes and narcotics; tonics are often required, and the usual diet may be allowed.

When the distinctive characters of hydrophobia make their appearance, and during the progress of the disease, curative attempts must be made. Many specific medicines have been used and extolled, comprising articles from the mineral, vegetable, and animal kingdoms, but all these so-called antidotes have signally failed. The whole list of remedies alluded to in the treatment of tetanus has been had recourse to, and with little effect; among the most prominent are the following: full and profuse venesection, but this has generally caused a more rapidly fatal issue; the free use of mercury, both internally and externally, to produce salivation, is neither specific nor beneficial, although a case of cure is reported in the *American Journal of the Medical Sciences*, vol. xxxix. p. 96, from drachm-doses of calomel; diuretics, drastic purgatives, and emetics are likewise of little benefit; the injection into the veins of warm water, as recommended by Majendie, or of solutions of opium and morphia, as suggested by Dupuytren, have failed.

The following are the general principles upon which we ought to act in our treatment of this disease: firstly, to allay the highly nervous and spasmodic affections by quieting the excited psychical and physical conditions; by the cautious administration of sedatives, opiates, and antispasmodics,—such as opium, morphia, belladonna, musk, chloroform, cannabis indica, &c.; by absolute rest, quiet companions, kindness and gentleness in speaking; by giving hopes; by the avoidance of all noises and draughts; by maintaining an equal temperature. Secondly, to support the vital powers by tonics, nutrition, and stimulants, so as to enable nature to combat with the disease. Thirdly, to alleviate urgent symptoms, such as thirst, by the use of ice, &c.; and to relieve obstructed respiration and impending suffocation from laryngeal spasms, by laryngotomy or tracheotomy.

Dr. Good writes: "It is highly probable that a spontaneous cure may be occasionally effected by the strength of the constitution or the remedial power of nature alone. The fact appears to be, that the disease requires about six or seven days to run through its course, at the expiration of which period the system seems to be exonerated, by the outlet of the salivary glands, of the poison with which it is infected. And hence, if by any means it be able to sustain and carry itself through this period, without being totally exhausted of nervous power in the course of so protracted and prostrating a conflict, it will obtain a triumph over the disease; and any prescribed medicine made use of on the occasion will seem to have effected the cure, and will run away with the credit of having done so, till subsequent instances dissolve the charm and prove beyond contradiction the utter futility of its pretensions. Our grand object must be to keep the patient alive, and prevent a fatal torpitude in the sensorium for a certain number of days, at any expense of stimulants or of subsequent debility. Wine is profusely given with great success in the bites of the most venomous serpents of the East, and analogy justifies us in proposing it in the present instance."*

GLANDERS.

Glanders is a disease peculiarly appertaining to the horse, consisting of a specific poison, which is highly contagious and capable of being communicated to the human species through the medium of inoculation. Although this disease has been recognised in the horse from the time of Hippocrates, yet it is only of late years that it has been satisfactorily proved to exist in man. It was formerly entirely overlooked, and the disease considered to be one of a purely local character attendant upon unhealthy and unclean wounds, terminating fatally. Dr. Elliotson was the first who accurately described the disease in man, and he termed it Equinia, as proceeding from the horse. Glanders essentially consists in an eruption of peculiar tubercles or deposits which manifest themselves under two distinct forms, which are, however, merely different types of one and the same disease. Thus, in the one form it attacks the mucous membrane of the nose and neighbouring glands, and constitutes what is termed glanders proper: this is the *morve* of the French, and *Rotz* of the Germans. In the other form it affects the absorbents or lymphatics and the skin, either of the extremities or trunk, causing enlargement of those parts, and producing a corded and knotty condition under the skin, not unlike worms; hence the term applied to this form by the Germans, viz. the *Wurm* or *Hautwurm*. It is known in England by the name of farcy or farcy buds, and in France by that of *farcin*. The disease generally appears in from three to six days after inoculation, although some affirm that it may not be developed for weeks or months after.

The symptoms of glanders in the horse are thus described by Youatt.† The local symptoms are, a nasal discharge, which is the earliest sign, and consists of an increased secretion, small in quantity and flowing constantly, and is of an aqueous character, mixed with a little mucus. It is not sticky when first recognised, but becomes so afterwards, having a peculiar viscidity and glueyness. The discharge soon increases in quantity, and becomes discoloured, bloody, and offensive in the advanced stages. On the other hand, the discharge may continue for many months, or even for two or three years, unattended by any other symptom, and yet the horse be decidedly glandered. The glands under the jaw soon become enlarged, and are generally observed on the same side as the affected nostril; the swelling at first may be somewhat large and diffused, but this subsides in a great measure, and leaves one or two glandular enlargements, which become closely adherent to the jaw-bone. The mucous membrane of the nose becomes of a dark purplish hue or almost of a leaden colour; never the faint pink blush of health or the intense and vivid red of usual inflammation. Spots of ulceration will probably appear on the membrane covering the cartilage of the nose: these ulcers are of a circular form, deep, and with abrupt and prominent edges, and become larger and more numerous, obstructing the nasal passages and causing a grating or choking noise in breathing. The disease extends upwards into the frontal sinuses, and the integument of the forehead becomes thickened and swollen, causing peculiar tenderness. The absorbents about the face and neck become now implicated, constituting farcy; these enlarge and soon ulcerate. The absorbents on the inside of the thigh, and then the deep absorbents of both hind legs, are next involved, causing them to swell to a great size, and become stiff, hot, and tender. The constitutional symptoms are, loss of flesh, impaired appetite, failing strength, more or less urgent cough; the belly tucked up; the coat unthrifty and readily coming off. The animal soon presents one mass of putrefaction, and dies exhausted.

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* Good's *Study of Medicine*, vol. iii. p. 303.

† Youatt *on the Horse.*

Respecting farcy, Youatt describes it in the horse as being a different type of the same disease: "It is an affection of the absorbents and their glands, usually attacking the extremities, commencing in a kind of glanderous chancre or ulcer. The absorbents open upon every chancre, and take up a portion of the virus, which is secreted by the ulcer, and as it passes along the absorbent vessels, these suffer from its acrimonious quality; hence the *corded veins*, as they are called by the farrier, or more properly the thickened and inflamed absorbents following the course of the veins. At certain distances in the course of the absorbents are valves, and these belly out and impede or arrest its progress towards the chest. The virus at these places causes swellings, which are very hard, even of a scirrhous hardness, more or less tender, and with perceptible heat about them. They are observed about the lips, nose, neck, axillary spaces, and thighs. Suppuration and ulceration next ensue. The ulcers are rounded, with elevated edges and pale surface; they are true chancres, and discharge a virus as infectious, as dangerous, as the matter of glanders. While they remain in their hard and prominent state, they are called *buttons* or *farcy buds*, and they are connected together by the inflamed and corded absorbents. The constitutional symptoms are, drooping; impaired appetite; loss of flesh; the coat will stare. The horse may then rally, and appear to be restored to health. By degrees, however, the affection soon becomes general; the myriads of capillary absorbents that penetrate every part become inflamed and enlarged, and cease to discharge their functions; hence arise the enlargements of the substance of various parts, swellings of the legs, chest, and head; these are sudden, painful, and enormous, distinguished by a heat and tenderness which do not accompany other enlargements."

In man the disease manifests itself in much the same form as in the horse, viz. as glanders or farcy; but in general these two forms are associated, commencing either as acute glanders followed by farcy, or as farcy rapidly succeeded by glanders; it is also more frequently attended with an extensive tubercular eruption of the skin of an exanthematous character. The disease passes through a premonitory stage, consisting of ordinary pyrexia, febrile excitement, &c., and then through its specific or eruptive stage, with its special local and constitutional symptoms. The stage of invasion, or the premonitory symptoms, commences with a feeling of indisposition or depression, and with peculiar wandering pains, followed by febrile excitement, shivering, great heat, and uneasiness; soon afterwards there is pain affecting the muscles simulating rheumatism, and often mistaken for it. This pain generally attacks the extremities, and more especially the bend of the groin, the axillæ, and neck; where, upon careful and minute examination, swellings may be detected, which are sometimes diffused and sometimes circumscribed, indicating glandular complication; these may disappear suddenly, or may be altogether absent. The fever soon assumes a more inflammatory character, the pulse becoming full, 92 to 96; the skin is hot and dry, the face flushed, and the head heavy; there is want of sleep, the tongue is foul, the urine scanty and high-coloured. Rigors ensue, there is profuse perspiration of a sour character, and diarrhœa may set in.

Sooner or later the second stage, that of eruption, takes place, and at once develops the specific characters of the disease. In acute cases this almost at once appears soon after the invasion, but in chronic cases there may be an interval of weeks. The following are the local and constitutional symptoms of this stage. The most prominent is the glanders' eruption, consisting of a crop of pustules, remarkably hard, simulating those of smallpox, and attacking the skin like an exanthem; it is considered to be peculiar and specific of the disease. Rayer has regarded it as quite distinct from the pock-pustules of ecthyma and other exanthemata. Virchow states, that although in outward appearance these resemble pustules, they are not so in reality, as they consist of a firm and tenacious deposit in the corium of the skin, of a whitish or yellowish material, over which the epidermis passes. He describes their development as follows: "At first there appear some red spots, which are very small, and resemble flea-bites, and soon acquire a papular elevation, subsequently rising above the level of the surface like small shot, assuming a yellow colour. These shot-like knots are either flat or round, and do not lie in a bladder-like elevation of the epidermis, but in a kind of hole in the corium, as if the latter had been punched out; they are not always solitary, but often disposed in groups. There is some surrounding injection, and under the epidermis there is found a puriform and yellow fluid, seemingly consistent, which is chiefly formed from softening of the knot. They are composed of a homogeneous yellowish substance, which is pretty firm and somewhat brittle, and have great resemblance to tubercle. Microscopically examined, they present an amorphous granular appearance, mixed with cell-elements and cell-growths, and numerous fat-globules."* Virchow considers them to be of cell-formation in the first instance, which subsequently passes into a cheesy condition, and then softens down, producing the pus of glanders and the farcy abscesses. They attack in a similar manner the mucous membrane of the nose, and the knots are small and linseed-shaped, and give rise to the peculiar nasal discharge. Softening of these tubercles next ensues, the skin gives way, and ulceration follows; and thus there are left small holes filled with débris.

These tubercles may be developed in other situations, such as in the subcutaneous cellular tissue, producing circumscribed, hard, and painful boils, or else diffused swellings of great extent, which either open spontaneously, or give rise to extensive sloughing of the skin and deeper structures; or, in rarer instances, subside, and reappear in other parts. This form is termed flying farcy. They may likewise occur in the substance of the muscles, more especially in those of the calf of the leg and back, forming distinct, hard, isolated masses, which are often exceedingly painful; but these more often are not observed until after death, when they may be found varying from the size of a millet-seed to that of a walnut, and in various stages of softening.

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* *Handbuch der Pathologie und Therapie,* Band ii. Abth. 1.

In the more advanced stages of the disease these eruptive tubercles or pustules attack the mucous membrane of the larynx, trachea, and bronchi, as also the lungs and pleura, causing pneumonia and pleurisy. Virchow considers that the part where there is most exudation is in the lungs; and here there is, for the most part, a series of tubercles on the surface, covered by a fibrinous pleuritic layer, and exciting internally lobular hepatisation, forming the pneumonia of glanders.

Occasionally the tubercles attack other organs, such as the testicle, infiltrating it, and simulating rheumatic orchitis; the kidneys; the pancreas; the serous and synovial membranes.

Some authors describe the eruption as consisting of phlyzacious pustules in livid patches and in small tumours which arise in different parts of the body; the pustules being round, and often umbilicated, containing a liquid purulent matter, with a little coagulated lymph in the form of a white soft substance, very similar to that contained in variolous pustules, and in the phlyzacious pustules induced by the external application of tartar emetic.

The mucous membrane of the nose, frontal sinuses, and parts adjoining, becomes involved, and the nasal discharge is one of the first symptoms of the disease, and may precede any visible eruption on the mucous membrane of the nose: at the onset it resembles more or less ordinary catarrh, and is thin and clear, like water; but afterwards, as in the horse, it becomes characterised by forming a thick, sticky, highly tenacious, puriform fluid, of a dirty yellow or red-brown colour, often mixed with blood. Should the patient be in a recumbent position, this discharge may flow back through the posterior nares, and escape observation, so that the practitioner may overlook the disease.

The nose and face become œdematous and swollen, of a dusky and shining appearance, which extends to the eyes and scalp; the conjunctivæ may be covered with thick secretion, glueing the eyelids together.*

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* The appearances of glanders, attacking the head and upper part of the body, are well displayed in the wax model in the Museum of Guy's Hospital.

The submaxillary glands are seldom involved in man; but the tonsils are peculiarly liable to be affected, and often large abscesses are formed in them.

The swellings and discharge increase, the latter becoming profuse and intense; inflammation extends; bullæ appear on the integuments, and abscesses form one after another; and gangrene sometimes attacks the nose, eyelids, &c.

The constitutional symptoms during the progress of the disease are severe, and at first of the inflammatory type, but soon assume a typhoid character; the pulse, 110 to 120; the skin hot, and covered with clammy sweat of a peculiar sour odour; there is excessive thirst; low delirium with tremors, and laborious respiration; coma supervenes, and death results from exhaustion. In many instances the symptoms resemble those of pyæmia.

The duration of the disease varies; in the acutest form it is fatal within a week, and death has taken place even within three days: in others it has lasted three or four weeks, and in some rare instances life has been prolonged for many months.

Such are the effects of acute glanders in man; but in many instances it is associated with acute farcy, which consists in the superaddition of inflamed absorbents and lymphatics, and is generally induced by the inoculation of a scratch or abrasion on the extremities; in these cases we have diffused suppuration of the limb, and suppurating glands.

The other modifications are the slow or chronic forms of the disease. The chronic glanders is remarkable for its slow development and course, and slow death; the discharge from the nose is fœtid and viscid, attended with pain and swelling of that part, as well as of the eyelids; abscesses form near the joints, and profuse perspiration and emaciation occur.

In the chronic farcy the wound degenerates into a foul ulcer, and the inflammation and suppuration of the lymphatics is slow and tedious, but it often terminates in acute glanders.

As an instance of the chronic form of the disease, the following case, quoted from Travers,* is appended. Nimrod Lambert, a healthy hackney coachman, æt. 32, infected a chap on the inside of the right thumb, by inserting it into the nostril of a glandered horse to pull off a scab. He remembered to have afterwards wiped the thumb with a wisp of hay. In the space of six hours he was seized with violent pain and swelling of the thumb; it inflamed rapidly. On the third day he was suddenly taken ill whilst driving with cold shivers and giddiness, and stated that he entirely lost the use of his limbs for seven hours. At this time his arm pained him much all the way up, and on the following day it was streaked with red lines and excessively swollen. The armpit was also much swollen and tender. In the evening of the fourth day he was carried to Guy's Hospital, where he lay during twenty-four weeks. Superficial collections of matter formed successively in the course of the absorbents. The corresponding portion of the integuments sloughed, leaving extensive ulcers which discharged an unhealthy and fœtid matter. The glands at either angle of the lower jaw and those of the groin became swollen, and he was much afflicted with pain between the eyes and down the nose, and ulceration of the membrana narium attended with discharge. During the progress of the local disease he had much constitutional illness. He totally lost his appetite, and was oppressed with nausea, complained of severe pains with swimming in the head, and occasionally wandered in mind. He had also much pain through the whole course of the spine, especially in the region of the kidneys. His urine was thick and discoloured, and fœtid; his motions were slimy and purulent. Expecting to die, he quitted the Hospital, and lay at home the remainder of the twelvemonth in a state of great emaciation from the continued discharge of his sores, and his inability to take food or procure any refreshing sleep, even with the assistance of opiates, which he took habitually. At the end of the twelvemonth his health gradually returned, the arm began to heal, and he became comparatively hearty and resumed his occupation, though with much inconvenience, owing to the distortion of his hand by the retraction of the thumb and forefinger, in the cicatrisation of a long line of abscesses, reaching to the middle of his upper arm. After six weeks this cicatrix ulcerated afresh and healed slowly. He became subject to wandering pains in the head, both sides of the neck, loins, and groin; was not so strong and so fleshy as formerly, but had a good appetite. He had a great heaviness and disposition to sleep during the day; and at the end of two years and a half from the breaking out of the disease considered his constitution broken, and despaired of being ever again the man he was.

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* *On Constitutional Irritation*, p. 362.

An ass was inoculated by Mr. Sewell with the matter of this man's sores, and died glandered.

With regard to the diagnosis of the disease in the horse, Mr. Youatt remarks, that it is chiefly recognised by the discharge from the nostril and by a singular hardness of the glands in the proximity of the jaw-bone, which are frequently actually adherent to it; these glands being rarely large except at first, and neither hot nor tender; the adhesions are owing to inflammatory action and the effusion of lymph on the exterior. He says if there be a doubt, the inoculation of a condemned horse or ass with the nasal discharge will reproduce the disease in a few days.

In man it is most difficult to recognise at its onset, as the symptoms do not differ from those of ordinary animal poisoning; at a later period it resembles rheumatism and typhus fever: but when once the eruptive stage is developed, all doubt will be at an end; the presence of a peculiar exanthem, the local nasal discharge, the affection of the absorbents, the knots in the cellular tissue and muscles, and the diffused suppuration, sufficiently attest its character.

Glanders is not to be confounded with an eruptive disease produced by the morbid fluids generated in the affection called *grease*, an inflammation and swelling in the heels of the horse, from which at a certain period a very acrid thin matter issues. This, when applied to any abrasion of the hands, gives rise to a pustular affection of the skin, and is termed *Equinia mitis*, in contradistinction to glanders, which is often called *Equinia glandulosa.* It is not at all uncommon among coachmen, stable-boys, farriers, and other persons who dress the heels of horses affected by the disease. The pustules are very similar to those of ecthyma, are elevated, and have a red, purple, swelled base; they are about the size of a sixpence, and vary in number; the pustules become purulent about the third day, and begin to dry about the tenth or twelfth, forming thick scabs, which leave well-marked cicatrices. It was at one time supposed to be the origin of cow-pox, but subsequent experiments have disproved this. Its treatment consists merely in rest and mild local applications.

The prognosis in glanders is very unfavourable; recovery rarely taking place unless early treatment be adopted, and in only mild cases of poisoning, where the activity of the virus is weakened.

Respecting the seat and nature of the disease there are several opinions. Some regard it as a purely local affection derived from atmospheric causes and engendering oxidation and acidification of the secretions, involving chiefly the lymphatics of the nose. Others consider it to be more often a spontaneous and primitive change in the blood, basing their opinion upon the fact that the peculiar secretion in glanders, when injected into the blood of a sound horse, produces the disease. Others, again, assert it to be a tubercular disease; and again, of late years it has been suggested to be a kind of pyæmia, from absorption of pus.

In man as well as in the horse the disease arises from contagion, and the most common medium is the nasal discharge, and the discharge from farcy swellings. According to some, the poison may be communicated through the blood, and Viborg states that it may be also from the saliva, urine, and sweat. Langenbeck found a peculiar fungus in the nasal discharge, which he considered to be the medium of contagion; this, however, has been proved to be accidental. Of the chemical nature of glanders-matter nothing is known.

Although the virus must come in direct contact with a wound or abraded surface, or fall upon some thin and delicate membrane, like that of the nose, in order to become absorbed, yet cases are recorded in which the surface was intact, and the disease produced by the wiping of the face with unclean hands or cloths.

Youatt states that there is not one-tenth part of the ravages from glanders now which prevailed thirty or forty years ago, and, generally speaking, it is now only found as a frequent and prevalent disease where neglect and filth and want of ventilation exist. He attributes the disease in the horse to the following causes: improper stable management, viz. want of ventilation, ill-drainage, bad pavement, want of cleanliness and comfort; any thing that injures or impairs the vital energy of the nose, such as fracture of the bones of the nose, violent catarrh, prolonged discharges from the nose; want of regular exercise, or excessive and undue exercise, as after a hard day's chase, and at the close of a severe campaign. Atmospheric influences have somewhat to do with its prevalence; thus it is not so frequent in summer as in winter, the air in the stables being then not so close or so foul, or so liable to alterations of temperature; and there are some remarkable cases on record of the connexion of moisture or moist exhalations with the cause of glanders. Hereditary predisposition has been mentioned by M. Dupuy, and supported by decisive cases.

The treatment in the horse is thus alluded to by Mr. Youatt:

"Wherever there is a glandered horse, or even a suspected one, prophylactic and preventive measures must be studiously adopted, great care and cleanliness, avoidance of all unnecessary contact, and especially sleeping in the stable; all wounds and excoriations should be well protected, and after unavoidable contact with the animals, or even the surrounding articles, a thorough and frequent ablution should be made. Great care must also be taken to avoid any discharge from the nostrils, during the sneezing of the animal, as it might be conveyed to the face, or eyes, or nose. In the horse, the disease may be avoided by providing cool and ventilated stables, good and efficient drainage, regular exercise, occasional green-meat in summer, and carrots in winter."

Mr. Youatt continues: "Considering the degree to which this disease, even at the present day, often prevails, the legislature would be justified in interfering by some severe enactments, as has been done in the case of the smallpox in the human subject. Where the life of a valuable animal is at stake, and the owner adopts every precaution to prevent infection, he may subject his horse to medical treatment; but in ordinary instances he is not faithful to his own interests, or that of his neighbours, who does not remove the possibility of danger in the most summary manner."

When the disease has become actually developed as acute glanders, there are no certain remedies. With regard to the treatment in the horse, Mr. Youatt writes: "There is scarcely a drug to which a fair trial has not been given. Blue vitriol and Spanish fly have held out the longest. Diniodide of copper has lately been used, but is not to be depended upon. The remedial measures to be resorted to are, a pure atmosphere, &c., considering that it is the peculiar disease of the stabled horse." Injections into the nostrils, and even trephining of the frontal sinuses for more effectual contact, have been had recourse to. "But," Mr. Youatt adds, "while glanders is incurable, farcy in its early stage and mild form may be successfully treated. As a general rule, and especially when the buttons or buds are beginning to appear, a mild dose of physic should be first administered. The buds should be carefully examined, and if any of these have broken, the budding-iron, at a dull red heat, should be applied. If pus should be felt in them, they should be penetrated with the iron. These wounds should be daily inspected, and if when the slough of the cautery comes off they look pale, foul, and spongy, and discharge a thin matter, they should be frequently washed with a strong solution of corrosive sublimate dissolved in rectified spirit. When looking healthy, friar's balsam is to be used. The constitutional measures are, the employment of bichloride of mercury, combined with tonics; cantharides, with vegetable bitters; diniodide of copper, employed as a stimulant and tonic. Together with these remedies, good air, full allowance of corn, green-meat, and carrots must be employed."

The treatment of the disease in man is likewise extremely unsatisfactory, for there are no certain remedies. Iodine and its preparations have been employed; Fowler's solution of arsenic and other mineral drugs are recommended, creosote, turpentine, &c. But the best constitutional treatment to be adopted seems to be that based upon general principles, viz. the alleviation of the concomitant symptoms, such as the distressing thirst, and the supporting of the powers of life by fresh air, generous diet, stimulants, acidulated draughts, and tonics in the shape of quinine or iron. At the same time, local measures must not be disregarded in order to arrest the progress of the local affection, and change its character if possible; these are highly important, and especially where the disease assumes a chronic form. Strong creosote solutions, nitrate of silver solutions, and other powerful astringents, are to be injected into the nostrils, or sponged over the entire surface. Solutions of chlorides and the chloruret of potash have also been recommended as injections and gargles, as also camphor and nitro-muriatic acid; turpentine embrocations and fumigations with volatile stimulating antiseptics, conveyed through the medium of warm aqueous vapour. When knotty tumours, boils, or abscesses form, these should be early and freely incised and the contents evacuated.

ALFRED POLAND.

WOUNDS OF VESSELS.

HÆMORRHAGE.

ALL wounds of vascular parts are necessarily attended with hæmorrhage from the vessels which have been opened by the injury. In the first moments after the infliction of the wound, the violence and amount of the bleeding depend upon the number and the smooth cutting of the opened vessels. In the majority of cases, the bleeding is stopped by the natural powers of the blood and wounded parts; and it is only when many or large vessels are concerned, or when the bleeding continues beyond the ordinary period and amount, that importance attaches to it. Injuries of the larger arteries and veins form the subject of separate portions of this work: the more frequent hæmorrhages of various kinds, which occur under other circumstances, will now be considered.

In all slight wounds the blood oozes forth evenly, without jerking motion; and being composed of the mixed contents of both arterial and venous twigs, it is intermediate in colour between them. Under ordinary circumstances, such hæmorrhage gradually and spontaneously ceases; but in others it persists. It persists, if the flow of blood to the part be encouraged by a high temperature, or by the force of gravitation on the blood, or by the muscular or the expiratory efforts of the patient. If the current of the blood along its natural channels be obstructed, as by pressure on the blood-vessel, the hæmorrhage persists. It does so, if the natural contraction of the bleeding vessels be interfered with, or if certain chemical agents or its own peculiar composition prevent the coagulation of the blood. Thus, a superficial laceration of the liver or spleen is in much the same condition as an external wound with a warm sponge upon it; the flow of blood is favoured by the high temperature of the interior of the body, and continues sometimes to a fatal extent. Such injuries of the liver bleed inordinately from another cause, viz. that the hepatic veins, not being contractile or surrounded by any loose tissue, cannot close, or even collapse. Obstinate hæmorrhage sometimes follows the extraction of a tooth, and the sawing across of the nutrient artery of a bone in an amputation. Whether previous disease have altered the tone of the artery or not, the fact appears to be, that the divided vessel cannot contract or collapse in the dense canal within which it is lodged. Varicose veins of the lower extremity, and those of the rectum, bleed, when they burst, with a double force; since, being unprotected by valves, they possess both an onward and a retrograde current of blood towards the part which has given way. The struggles and cries of a patient greatly increase the bleeding from wounds of the almost valveless veins of the head and neck, especially if the person be restrained in a recumbent posture.

Hæmorrhage, whether it declare itself by the external discharge of blood from a wound or through any of the open canals of the body, or be concealed by the accumulation of the blood within a closed cavity, is attended by general symptoms, sufficient to indicate what is going on. The ruddy tint of the integument departs; the lips and conjunctiva appear blanched; the withdrawal of blood produces a disproportion between the size of the arteries and their contents, and the pulse is at first small; it also increases in frequency, the heart labouring to make up in rapidity of action for the small quantity of blood which it sends forth at every beat. A feeling of languor, yawning, throbbing of the temples, impressions of noises and of light come on; the surface loses warmth; and at length the heart and brain somewhat suddenly cease from their functions, the patient becoming unconscious and falling down, and the pulse being nearly, or for a time completely, interrupted. The breathing during this syncope is very feeble, and performed only by the diaphragm. If the flow of blood continue under these circumstances, the patient dies; but if, as is far more commonly the case, its issue should cease, rapid coagulation takes place at the orifice of the vessel, and the plug thus formed prevents the immediate recurrence of the bleeding. An attack of vomiting often accompanies the return of consciousness. The heart resumes its function, at first feebly, and afterwards with frequency and even with violence. The pulse is jerking, soft and easily compressible, the wall of the artery being soft and large, and contracting very incompletely after the small wave of blood has shot through it. All the soft tissues of the body lose their usual tension and plumpness, and the features of the face are thinned. These changes result partly from the mere absence of blood, as a tumour feels less hard after its removal from the body than when injected by a continuous current of blood; partly also they are due to the diminution of the fluid constituents of the body, which have been rapidly absorbed for the purpose of refilling the blood-vessels. Extreme or repeated hæmorrhage, such as occurs from the opening of an artery or from lacerations of internal organs, occasions faintness, sighing, restless tossings, with the other symptoms already described, sometimes amaurosis, and at length delirium or convulsions. The actual death may take place suddenly upon the patient's assuming the erect posture, or lifting both hands above the head; or it may be gradual and preceded by insensibility, with stertor and puffing of the cheeks, and copious cold perspirations of several hours' duration. The occurrence of death during hæmorrhage, however, cannot always be ascribed to the quantity in which the blood has escaped, since patients differ much in their endurance of loss of blood. Infants suffer most from this cause. One adult may fall into syncope at the abstraction of twenty ounces of blood; another, standing, with his back towards a large fire, will bear the loss of more than fifty ounces before feeling faint. And in other instances it may happen that death is not due so much to the quantity of blood lost as to the hæmorrhage being associated with terror, with other physical disease, or with the influence of a suicidal mind.

The change in the density of the blood, which has been described as a result of continued hæmorrhage, renders it unnaturally liable to escape from the blood-vessels. In persons who are suffering from hæmorrhage in one situation it may accordingly happen, that smaller extravasations of blood take place in distant tissues. Such secondary bleeding occurs in uninjured parts of the body, and in persons who may be assumed to be healthy, since it will follow when the primary hæmorrhage has been the consequence of a wound. Thus, I have observed ecchymoses in distant parts of the body of a patient who had died of traumatic abdominal hæmorrhage. Dr. Denman reported an instance of fatal cerebral apoplexy in a patient who had suffered from uterine hæmorrhage for seven years;* and Mr. Travers another, which occurred during the performance of venesection for an attack of pneumonia.

The hæmorrhages which have been considered above are such as occur in persons of ordinary health, and are not modified by any peculiarities in the construction of the blood-vessels, the composition of the blood, or any more occult or constitutional cause. Yet there are not a few instances of hæmorrhage, for the treatment of which the aid of the Surgeon is sought, and in which, without a visible breach of surface, the blood pours forth from mucous membranes or from the skin, or accumulates, as it is extravasated, in the natural serous cavities, or in the areolar and muscular tissues. The prevalent hæmorrhage of young persons is epistaxis; that in adult life is hæmoptysis, hæmatemesis, or hæmaturia; while the commoner source of bleeding in declining years is the rectum, and in the aged, the brain. This assignment of hæmorrhage in particular situations to separate periods of life is, however, only generally correct. Children may die of cerebral apoplexy, and epistaxis may put life in danger after fifty years of age. Instances of both these facts have occurred to me. Of the several forms of bleeding above enumerated, a sufficient cause is found, when disease of the bleeding part, or of some organ closely connected with it, is discovered. Cancerous growths, tubercular ulcerations, mere overfilling of the veins of a superficial membrane, if permanent, explain many such hæmorrhages. Subconjunctival and retinal ecchymoses thus occur during a cough, and in obstructive heart-disease. But these sometimes, and oftener the other examples of spontaneous bleeding, cannot be thus explained. They are brought about by some less manifest defect in the blood, the blood-vessels, or the bleeding tissues, or by the influence of some constitutional fault or necessity.

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* *Transactions of a Society for the Improvement of Medical and Surgical Knowledge*, vol. iii. p. 315.

That hæmorrhage should sometimes persist in an inordinate degree, as a consequence of a defective coagulating power on the part of the blood, might be expected from the number of known instances in which no coagulation whatever takes place. The entire absence of clots in the heart and blood-vessels of certain bodies, when examined after death, whatever the cause of their absence, prepares us to find such deficient coagulating power occasionally during life.

Again, we might readily attribute some influence in the production and continuing of bleeding to a defective construction of the blood-vessels, when we regard the cases of Wilson, Blagden, and Roux; in which, without other assignable cause, hæmorrhage from such vessels proved fatal. Wilson, in his Lectures at the College of Surgeons, in 1819, mentioned his having found the arteries possessing but half their natural thickness in a person who had died of uncontrollable hæmorrhage.* Mr. Blagden's case may be thus abridged.

The patient, when a boy, bled for twenty-one days from the alveolus, after the extraction of a tooth. Whenever he cut himself accidentally, hæmorrhage took place to an extraordinary amount, and was difficult to stop. At twenty-six years of age he received a slight wound of the forehead, and an enormous bleeding issued from a wounded artery. It was stopped for a time by the application of a ligature on either end of the vessel; and this was observed by the surgeon to be very thin in its coats, and like a vein rather than an artery. Kali purum was applied, and it stanched the bleeding, but occasioned extensive sloughing. In the following year he again had a tooth extracted, and suffered profuse hæmorrhage from the alveolus. Lunar caustic, blue vitriol, cold, plugging the alveolus, the actual cautery, all were tried, but only temporarily controlled the bleeding. On the sixth day he was greatly exhausted, and the bleeding returned. Sir B. Brodie tied the common carotid artery; yet the hæmorrhage continued. The wound made in the operation bled very little at first, but in a few minutes it also began to bleed profusely. No single vessel could be observed bleeding, but there was a general oozing from its surface, which was for a time suppressed by the application of ice. On the seventh day, however, the patient died of a return of the hæmorrhage.

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* Lane, *Lancet*, 1840.

The carotid artery had several opaque white depositions on the outer surface of its inner coat. The temporal and some other branches of the external carotid appeared to have thinner coats than usual, and to be nearly transparent.*

If, again, the tissues adjoining and involved with the bleeding vessels be examined, some share in permitting at least, if not in actually causing, the obstinate hæmorrhage may appear to be assignable to them. Wounds, when such bleeding follows wounds, do not readily undertake processes of repair. The granulations, which subsequently form on them, are large and flabby; they bleed readily and long upon the slightest injury, and are sometimes distended like bladders by hæmorrhage into their substance. Such wounds heal slowly, and sometimes not at all; they may be covered for a long time with a blackish scab, or with a waxy matter or plug. If a cicatrix form over them, it is very thin, and, even when completed, may permit a fresh oozing of blood to take place through it. What is the condition of the Schneiderian membrane during epistaxis, and of other mucous membranes which bleed when not wounded, may be inferred from the appearance of such bleeding scars. If the blood be sponged away, fresh minute drops are seen to collect upon very small and numerous blackish orifices, and, after uniting into a larger drop, to flow off. A similar appearance was presented by the skin of the finger of a young woman, from which severe spontaneous hæmorrhage sometimes took place.

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* *Med.-Chir. Trans.* vol. viii. p. 224.

But, although there may in different cases be a fault in the blood, or the vessel, or the tissue, yet neither one nor all of these can be regarded as the principal and final cause of the hæmorrhages under consideration. The following are some of the circumstances in which they occur.

The regular monthly flow of somewhat altered blood from the inner surface of the uterus is in some persons interrupted, while at the same time blood oozes from the most various parts of the body, from any of the mucous membranes, from the skin, or from an unhealed ulcer or a cicatrix. In the punctuality of its monthly recurrence, in the similarity of its duration, in the quantity of fluid blood which transudes, in the relief it affords to the system from the ordinary symptoms of amenorrhœa, this hæmorrhage shows its identity with that of the natural catamenia, and the propriety of its being considered to be a substitutionary, or, as it is termed, a vicarious, menstruation. The proof that this is its real nature and cause may be regarded as complete, if we add that the hæmorrhage so named occurs in a part, which both before and afterwards may be without a trace of ulceration or wound, and that it ceases when the uterus resumes its natural periodical function.

Periodical hæmorrhage is by no means restricted to persons of the female sex, and is not in them universally associated with the cessation, or even with any ascertained disorder, of the menstrual function. I have been informed by Mr. Holmes of the case of a woman, in whom hæmorrhage went on for many years from an unhealed part of a stump. No remedies, constitutional or local, availed to stop it, and the stump was amputated with the hope of obtaining a healthy surface. The hæmorrhage recurred as before, from the second stump, and the case was finally given up as hopeless. The menstruation in this patient was regular, and its occurrence had no perceptible effect upon the bleeding. The blood also appeared to be natural, and the arteries sound. There was no unusual amount of bleeding at either amputation, or trouble with secondary hæmorrhage afterwards. Neither was there any evidence of the hæmorrhagic diathesis. In some persons a periodical hæmorrhage occurs annually; in others at shorter intervals. Some such bleedings are even hereditary; especially is this the case with hæmorrhois in men. Led by the exactness of its monthly recurrence, and by some other less obvious characteristics, Gall and Chomel claimed for the hæmorrhage occurring in some male patients the menstrual character. The former even asserted that there naturally is a periodic change in the male system, corresponding in time and nature with the monthly excitation of the female, and unlike it only in being unaccompanied with hæmorrhage. With regard to other cases of recurrent constitutional hæmorrhage, of which no local or general cause can be ascertained, it has been surmised that the production of blood in such persons exceeds the quantity expended in the nourishment of their tissues, and that hæmorrhage occurring when the surplus of blood has accumulated in the vessel is at once the consequence of the repletion, and the means of its relief.

An uncontrollable propensity to bleed is the chief character of the disease commonly known as the Hæmorrhagic Diathesis. Upon the slightest breaking of the surface, a scratch of the gum or a prick of the finger, the blood leaks forth incessantly, and no more effort to stay its flow appears to be made either by contraction of the blood-vessels or by clotting of the blood, than if the stream were water, and the tube it flowed through were a metal cock. A case of this kind is occasionally met with in England. Two of a family of seven children were recently admitted into the Middlesex Hospital for very long-continued and exhausting hæmorrhage, proceeding from trifling wounds of the gum and finger; a third child, of the same family, having already died from bleeding after biting its tongue, and others having exhibited the hæmorrhagic tendency. But instances of the disease are rare in any country, in comparison with their frequency in certain parts of Germany, and more numerous and complete records of its characters have accordingly issued from that than from any other country.

It is sometimes observed that the characteristics of the hæmorrhagic diathesis may be induced in a young and previously healthy person by the privation of fresh air, light, and nourishing food, and by confinement in a damp low situation; and that they will disappear again upon replacing the patient in conditions favourable to health. It does also undoubtedly happen that, without exposure to unhealthy influences, and without traceable hereditary taint, the hæmorrhagic diathesis shows itself for the first time in adult life, and remains as a persistent disease. But most commonly it appears as congenital, inherited, and too often ineradicable. It does not select manifestly unhealthy persons, or exclusively affect any particular period of life. Infants die of it as their navel-string separates; growing children and adults lose enormous quantities of blood from it, and at length may bleed to death. Some persons survive till past sixty years of age, and, though they have bled severely at various periods of their lives, die at last of disease unconnected with the hæmorrhagic peculiarity of their constitution. The diathesis probably exists equally in the male and the female children of a family, although it does not equally show itself; for, while the hæmorrhages come on early amongst the former, and are fatal to them in their boyhood, the girls mostly survive the age of childhood, and exhibit the diathesis either by themselves dying of some inordinate hæmorrhage from their generative organs, or by giving birth to children who present evidences of the same diathesis. Men having the hæmorrhagic tendency, who marry healthy wives, do not appear capable of conveying the tendency to their offspring.

The bleeding is sometimes spontaneous, sometimes the result of a wound. In the former case it may be periodical: there is an instance of its recurring annually in a child on the fourth day before his birthday, and on the fourth or fifth occasion proving fatal. But whether the spontaneous hæmorrhages recur at regular or irregular intervals, they always continue for a long period; they drain the body of nearly all its blood, and cease only with life or from long-continued syncope, which appears like death. When the hæmorrhage arises from a wound, it differs in its severity according to the nature of the injury. Clean wounds sometimes bleed moderately, even in persons who are known to have the hæmorrhagic tendency, and venesection is sometimes resorted to without injury as a means of relieving them from a threatening attack of spontaneous hæmorrhage. Yet even such wounds in these persons cannot be regarded as free from danger, since some have died of bleeding from the incisions made in surgical operations; and an instance is recorded in which a boy, who had been bled, was found to have died in his bed of hæmorrhage from the lancet-wound. The bandage remained firmly applied upon the wound. The most certain and uncontrollable hæmorrhage is that, however, which happens from lacerated wounds, and from those which have been kept from closing by the sucking of a leech or by a cupping-glass. Small contused and lacerated wounds bleed more than larger ones; and it has happened that a small wound of this character has ceased to bleed when a surgeon (Fordyce) has enlarged it by incision. The most commonly fatal injury amongst these persons is the extraction of a tooth, after which operation the lacerated vessels of the alveolus sometimes never close.

The blood which issues from a recent wound differs in no manifest quality from that of a healthy person. It coagulates after flowing off, though it does not do so to any effect in the wound itself. Some few investigations have shown, moreover, that it possesses an equal quantity of fibrin in this diathesis with that in the blood of other persons. But as the hæmorrhage continues, this character of the blood is lost; it no longer coagulates, it becomes thin and watery, and leaks forth more readily, if not more abundantly, than ever. The importance of arresting the bleeding from wounds as early as possible is thus shown, since hæmostatic remedies become of less and less avail the longer the blood flows.

The subjects of this peculiar disease are likewise liable to hæmorrhages in various tissues, to ecchymoses on all parts of the body, and to the formation of bullæ on the skin, which also become filled with blood. The readiness with which blood oozes into the tissues in these cases is of no little importance in a forensic point of view, since the appearances presented by a body thus marked might lead to the erroneous supposition that a very considerable and culpable amount of violence must have been inflicted. Indeed, the disease materially affects the whole social relations of the sufferer. However adapted by mental vigour or by physical strength, he is entirely unfitted by it for any occupation which might require him to handle edged or pointed tools. Neither the army nor the navy, no agricultural pursuit, none of the hardier handicrafts, may be chosen for his occupation in life; but such only as he can pursue with the least probability of his wounding himself or being wounded by others.

In early childhood, and sometimes after the full growth has been attained, these 'bleeders,' as they are called in Germany, are prone to affections of the joints, presenting some of the characters of rheumatism. The disease of the joints may vary in different individuals between mere pain and the most considerable swelling; but in many families no individual, who has the hæmorrhagic diathesis, fails to suffer also from some degree of the articular disease. Not unfrequently pain will come on in a joint, particularly in spring-time or harvest, and after passing irregularly from one joint to another will settle in the knee, and be followed by a painless enlargement of that joint, not unlike a white swelling. As the joint enlarges, some habitual indication of the patient's diathesis, piles or hæmorrhage, for instance, will cease, and not recur so long as the joint continues swollen.

Before speaking of the treatment which these cases require, it may be advantageous to furnish the entire histories of one or two hæmorrhagic patients. I select one from Grandidier's interesting monograph on the disease.*

"Heinrich M., forty-four years of age, the son of a man-servant still living, is a strongly-built man, five feet nine inches in height. The hair of his head and beard is black, his eyes are of a clear blue colour. He was delicate in his early childhood, and as he grew up he suffered much from rheumatic affections of the joints; his feet especially remained weak from this cause, and they still prevent his walking quickly. From the first year of his life he has been subject to hæmorrhages, both spontaneous and traumatic. Those which were spontaneous issued from the nose and the gums in his earlier years, but more lately from the urethra and rectum. The attacks of bleeding are always preceded by great restlessness, by pulsating and throbbing of all the arteries, and by a feeling as if they would burst. He states that he is warned of the approach of the bleedings some week or fortnight before by the continual odour of fresh blood in his nostrils. At the expiration of the period of warning, slight hæmorrhage from some part of the body begins, and usually continues a fortnight or three weeks. At first he is able to continue up and about; but after a week he is compelled to take to his bed, and from that time the bleeding increases in severity, and continues, whether he wake or sleep, until at length the blood is quite clear and appears like lymph. In a state of prostration and unconsciousness, he then lies as one dead for several days. When the flow has ceased, he slowly returns to life and consciousness; but many weeks pass before he loses his paleness and the feeling of languor and exhaustion. Gradually, however, as appetite returns, he begins to make blood again, and after a few months he once more blooms 'like a rose.' He is bright and clever, and has a good deal of mechanical ingenuity. The sexual passion was never inordinate in him, as is reported to have been the case with one of Wachsmuth's patients. When three years of age he fell and bit his tongue; the wound bled for eight days, and the enormous hæmorrhage could not be stopped without surgical help. Up to his seventh year he bled frequently and severely from the nostrils; after that age the blood issued from the gums. The gum would become congested and swollen, and at some one spot upon it drops of blood would appear; after a time smart hæmorrhage would come on, and continue for a fortnight or three weeks, until he lost consciousness. In his nineteenth year he cut his thumb, and the wound went on bleeding for three weeks. As he was without surgical assistance, and all domestic remedies proved useless, he had a bandage applied round the arm near the wrist. The bleeding stopped, indeed, but such swelling of the hand and arm came on that he was obliged to have the ligature removed. The hæmorrhage then recurred, and continued until he was perfectly exhausted. In another week the wound had cicatrised.

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* *Die Hämophilie, oder die Bluterkrankheit;* Leipzig, 1855, p. 28.

"After he had reached the age of thirty-one, the gums rarely bled, and hæmaturia became the prevalent hæmorrhage. It was always preceded by severe dragging pains in the region of the kidneys; the blood which passed by the urethra was sometimes fluid, sometimes coagulated. Two years ago he had continuous hæmorrhage from the gums for two days, and for three days subsequently hæmaturia. On the fifth day, being quite exhausted, he took to his bed. Towards morning he was awoke by the action of his bowels, and in the course of an hour discharged by the anus more than a pailful of pure blood. The bleeding was then at an end, for, as he expressed it, 'I had no more.' He lay for the next twenty-four hours without consciousness or movement, and as if dead; and was not in a condition to walk again for eight weeks. On one occasion, the lungs furnished the blood in large black lumps. This propensity to hæmorrhage is recognised in his family as an inherited disease, there having been three other instances of it amongst his mother's relatives. His grandmother's sister's son bled to death in his thirtieth year, from a small scratch in the neck. His mother's brother died in a short time of hæmorrhage from the nose and mouth. His mother's sister's son is also the subject of hæmorrhages, but is still alive. All the 'bleeders' of this family from their first year of life had raven-black hair."

The consideration of the treatment of this disease involves at least two questions; its general management, with the view of preventing the attacks of bleeding and of obtaining a radical cure, and the propriety and means of arresting existing hæmorrhage. The former question has been especially studied by Wachsmuth,* who wrote the first monograph on the subject. He had the painful opportunity of watching and treating the disease in one of his wife's brothers, and two boys of his own family. Other relatives of his wife had also died of hæmorrhage; one of them, a girl of twenty, from laceration of the hymen.

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* *Die Bluterkrankheit*, von Carl Otto Theodor Wachsmuth; Magdeburg, 1849.

From the observations which he made upon the nature and progress of the disease, he concluded that two essential and congenital conditions contributed to it,—an exalted vitality of the blood, and a delicate construction of the capillaries. Many of the circumstances of the disease appear to support this conclusion. *α*. Its intermittent character. *β*. The strong action of the arterial system, and the mental and bodily excitement, which forebode the attack. *γ*. The immunity from excessive hæmorrhage, even after wounds, in the intervals between the attacks. *δ*. The rare occurrence of bleedings in persons who have some established outlet for their superfluous blood, as men with hæmorrhoids, and women during their years of menstruation. *ε*. The facility with which bleedings are sometimes prevented or arrested by means which lower the vitality of the blood, as spontaneous diarrhœa, smart purging, and, in one remarkable case, excessive sexual indulgence. *ζ*. The proneness of 'bleeders' in their earlier years to inflammations of the lungs; of organs, that is to say, concerned in purifying this highly vitalised blood. *η*. The readiness with which ecchymoses form under the skin upon very trifling pressure or injury. The indications for general treatment follow from this view of the nature of the disease, namely, to lower the exalted vitality of the blood, and to raise the tone of the capillaries. The mode of following these indications may, perhaps, be best shown by Wachsmuth's account of the treatment of his eldest boy.

One or two traumatic hæmorrhages during the first year of his life could only be stopped by the actual cautery. Spontaneous bleedings afterwards came on, and put the child's life in danger. "As all the internal and external styptics proved of no service, the thought occurred to me to try an infusion of arnica. The action of this remedy gave me much satisfaction; it arrested the bleeding in the course of three or four days, while without it the blood would flow for twice that period, and cease only upon the occurrence of syncope. I had already tried Glauber's salts, not only on account of Otto's recommendation, but also because I had observed smart purging to stop the bleedings. My brother-in-law used to be much benefited by it; but my little boy, though also relieved as to the hæmorrhage, was too much exhausted by its use. . . . . I kept the child mostly out of doors, had him washed or bathed every day in cold water; ordered him a light, unirritating diet, chiefly of animal food, and gave him the carbonate of iron regularly, with the exception of a pause every four weeks. I subsequently employed the cod-liver oil. When a considerable period had passed without any hæmorrhage, and the boy showed much excitement, his face and ears flushed, &c., I gave him Glauber's salts for several days together in smartly purging doses. For arresting hæmorrhage, I have long since substituted for arnica the secale cornutum" in five-grain doses every half hour.*

In treating the spontaneous bleedings, it must not be forgotten that they are of a critical nature; and that if arrested too soon, they are sometimes replaced by hæmorrhage in some important organ. "A short time ago, during my eldest boy's spring attack of hæmorrhage, I made some experiments as to the critical import of the bleeding. The preliminary symptoms had existed for a long time, and I gave him only small doses of Glauber's salts during the period of a fortnight. No hæmorrhage occurred. For the following week I left the child free from all medical treatment. The tokens of congestion, which had almost entirely subsided, were now renewed; still I did not interfere, and after a few days a smart hæmorrhage took place. I then gave the secale cornutum, and the bleeding continued till evening. The boy was very restless in the night, the orgasm of the blood became more and more manifest, and at noon of the following day the bleeding recommenced. When it had lasted three days, I gave the ergot again, and the hæmorrhage ceased. From that time no further excitement in the vascular system recurred, and the boy remains well."†

The hæmorrhages arising from wounds in these subjects do not appear to yield to the same plans of treatment as those which are spontaneous. Glauber's or Epsom salts do not abruptly cut them short, and too often the ordinary styptic applications disappoint the Surgeon by only arresting the flow of blood for a time, or by even failing altogether to do so. The actual cautery is the least uncertain styptic in these cases. Long-continued pressure has occasionally proved effectual in stopping bleeding from the alveolus after the extraction of a tooth. These and the other measures recommended for the general treatment of hæmorrhage in this article may be adopted.

Treatment of hæmorrhage. The following rules will be found applicable to the treatment of ordinary hæmorrhage.

In many cases of moderate hæmorrhage the blood which has escaped and coagulated in the wound appears to be a chief cause of the continuance of the bleeding; and completely removing the clot and exposing the bleeding point are speedily followed by the cessation of the hæmorrhage. The importance of this practice cannot be over-rated; it is applicable to almost all cases but those of severe arterial hæmorrhage, and is even successful in some instances of arterial bleeding from the palm of the hand. The exposure of the surface of stumps, and other surgical wounds, to the air, for some hours after operation, has almost invariably the effect of preventing secondary hæmorrhage. The wound may be closed after six or more hours by means of sutures, introduced, but not tied, at the time of the operation. I have never known it requisite to reopen a stump or wound so treated, and the contraction of the soft parts during the exposure is very remarkable. In the *Medico-Chirurgical Transactions* will be found a valuable illustration of the advantage of exposing bleeding vessels. "A man was admitted into St. Bartholomew's Hospital for a wound of the calf, which bled unceasingly within the integuments, until the extravasated blood had raised them from the ham to the heel. Mr. Lawrence laid open the whole of the vast cavity and turned out the clots, but he could find no single bleeding vessel. The hæmorrhage ceased at once, and did not return."*

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* Loc. cit. pp. 10, 11.

† P. 55.

The elevation of the bleeding part greatly influences hæmorrhage, and should be attended to, whether the bleeding point be in the pelvis, the head, the neck, or any of the extremities.

Cold applications to the wound and adjoining parts appear to act in two ways in restraining hæmorrhage: they encourage contraction of the bleeding vessel and cause it to be compressed by the shrinking of the soft parts; and they also diminish the quantity of blood which arrives at the bleeding point. Ice is, accordingly, a valuable auxiliary in the suppression of hæmorrhage. It may be laid upon a wound, introduced into it, passed within the rectum, or otherwise applied, as suits the circumstances of the case. A current of air is also very efficacious.

Pressure, when well applied upon a bleeding point, will stop great hæmorrhage. It should be accurately directed upon the bleeding vessel, and should, if possible, though not necessarily, be made in the wound. The first pad must be small and firm, and should be laid on the bleeding orifice without any intervening clot. Each additional pad should be larger than the one beneath it, but need not fill the wound; and the whole should be firmly bandaged. Care is required to adjust the pressure upon the pads to that amount which shall be sufficient to stay the bleeding, and not occasion sloughing of the compressed parts, or of the limb below them. The pressure on the pads over a wounded palmar arch is sometimes effected by turning the bandage over the two ends of a stick or yoke, which crosses the back of the hand. If the tension of the bandage be not moderate, the compressed soft parts at the back of the hand may slough. In many cases it is advisable to support the distant parts of the limb, and each finger or toe separately, by bandaging them before compressing the pads.

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* Vol. xxix. p. 53.

Medicated astringents act directly upon the flowing blood. They can be useful only in the wounds of vessels of moderate size, and when they reach the blood as it issues from the orifices of the vessels, and cause it to coagulate into a firm plug. A small pad of lint, soaked in the oil of turpentine, the perchloride of iron, or the tincture or infusion of matico, should be laid and held on the bleeding point. Turpentine, lead, opium, gallic and tannic acids, given internally, dispose the whole mass of the blood to coagulate, and thereby assist to stop hæmorrhage from any particular point. The bleeding arising from the hæmorrhagic diathesis is sometimes controllable by a few doses of the oil of turpentine.* A full dose of crude opium is often of great service in arresting that oozing of blood from a number of small vessels, which is occasionally observed after surgical operations.

Other modes of treating hæmorrhage arise out of the circumstances of the case. Nitrate of silver, potassa fusa, or the actual cautery, may be applied to the bleeding point. A small needle may be passed through the skin across a bleeding leechbite, or umbilicus of a child, and the flow finally arrested by firmly applying a figure of 8 ligature.

Transfusion.

When a patient is reduced by hæmorrhage to a state of extreme danger, experience may justify the employment of transfusion. Mr. Lane, finding a lad drained of nearly all his blood and on the verge of death, injected into a vein of the patient's arm about five ounces and a half of blood freshly drawn from a healthy young woman. No immediate change followed the injection; but in the course of an hour or two the lad had so far rallied as to be able to sit up, and drink water from a cup which he held in his own hand. He had also no return of the hæmorrhage.* The name of Dr. Blundell is permanently associated with the operation of transfusion, in consequence of his extensive investigations in respect to it, the orderly representation of the facts which he made in his memoir on the subject, and the systematic directions which he gave for the performance of the operation. His conclusions on the subject are too numerous to be given here: the reader who wishes to ascertain them is referred to the Memoir, which may be found at the end of Dr. Ashwell's work on *Parturition.* The chief points to be observed in performing the operation are as follows: the transfusion should not be delayed until the patient is *in articulo mortis;* nor should it be on that account declined: human patients have been rallied from that state by means of it, and some animals, even after respiration has ceased. The blood to be injected should be human blood; and it is advisable to take it rather from a man than from a woman, the former being less likely to faint in such critical moments. If the operator be familiar with the transfusion apparatus, he may use it; but if not, he may more promptly rescue his patient with an ordinary syringe, the nozzle of which is fitted to the tubule required for the vein. A vein in the patient's arm is to be fairly exposed by an incision, and opened longitudinally; the arm is then to be bound below the incision, to prevent hæmorrhage from below. The syringe, having been made warm, not hot, is to be charged with the blood furnished for transfusion into a tumbler or conical receiver: by elevating the nozzle and forcing on the piston all air will necessarily be driven out of the syringe; and the tubule having been inserted into the vein, "without hurry or delay the blood is to be injected in an equable stream." The capacity of the syringe being known, and care being taken to keep the tubule fairly within the vein, there need be no difficulty in determining the quantity of blood which has entered the circulation. The circumstances of the case must determine the surgeon as to the quantity which he will throw in: some adults have not been resuscitated when sixteen ounces of blood were injected. Mr. Lane's case of a boy rallied after receiving five ounces and a half. The state of the blood should be carefully attended to during its flow, as it must be cast away, and warm water passed through the syringe, if any sign of coagulation appear.

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* Vincent's *Observations on Surgical Practice,* p. 216.

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* *Lancet*, 1840, p. 186.

INJURIES OF VESSELS.

THE effects of injuries of vessels, whether arteries, veins, or capillaries, and the method by which those injuries are repaired, differ essentially according as the skin covering them is broken or entire. Much importance often attaches to the circumstance of the sustained injury being a wound or a bruise; a laceration of vessels, from which the blood escapes freely outside the body, and is wasted, or from which it passes into other torn parts, and is infiltered and pent amongst them. In the opening of large vessels this difference involves the immediate death or safety of the sufferer. It affects only the mode of repair and the liability to subsequent erysipelas and inflammation of the absorbents, when the divided vessels are small; for from these diseases the patient is exempt, so long as the bruised and torn parts and the blood lying amongst them are enclosed by unbroken skin.

The readiness with which the areolar tissues of the human body admit of being percolated by liquids is shown by the rapid extension of emphysema to distant parts, and the great inflation of the trunk, which sometimes take place when the atmospheric air is pressed into them through an opening in an air-passage, or when, by the ulceration of some portion of the intestinal canal, gas and liquid fæces are ejected into those tissues by the force of the muscular wall of the bowel. In one case of the latter kind I found fœtid gas about the right knee, the track of which could be followed back to the appendix vermiformis, as the point at which it had escaped from the bowel. Extravasations of urine and the phenomena of anasarca illustrate the same fact. It is accordingly not surprising that blood which has been driven forth from ruptured blood-vessels, and detained within the body by unbroken skin, should filter through the neighbouring loose tissues rapidly and far. It is not uncommon for blood thus to travel from a bruised spot along the whole lower extremity, marking its course by a stain of the skin, wherever it approaches the surface so nearly as to be seen.

From what has been said it will be evident that the quantity of blood which may be extravasated in cases of subcutaneous laceration of the tissues will be proportioned to the size and number of the bleeding vessels, the force of the circulation in them, and the duration of the hæmorrhage; whilst the distance which the blood may travel will partly depend on the quantity thrown out and the force of its ejection, and partly on the looseness of the structures which it traverses. All these conditions modify the consequences of a laceration of vessels. Thus the firmness of the structures in a healthy adult limits the diffusion of the escaping blood, and causes its accumulation in the lacerated parts, whilst the emaciated and loose tissues of the aged permit blood to ooze through them in so great a quantity that the circulating system and the vital organs may be seriously drained of this important fluid. It is interesting also in this point of view to observe the barrier opposed by a fascia to the diffusion of blood; to see, for instance, how freely blood finds its way throughout a contused eyelid, and how long, if not altogether, the extravasation remains limited to that part. Equally, if not more, important are the extent of the subcutaneous laceration of the tissues, and the size of the vessel or vessels which communicate with them. For the most part, the hæmorrhage continues until the torn spaces are full and tense, when it is probably arrested by the pressure, and coagulation of the blood closes the open vessels.

WOUNDS OF ARTERIES.

THE state of the integuments becomes a matter of greater importance in proportion to the size of the wounded vessel. If there be an external wound communicating with an opening in an artery, the result is *hæmorrhage*. The blood equally escapes from the artery if there be no external wound, but it is then for a time confined within the structures of the part, and constitutes an *aneurism*. The former condition is the subject of the present section: the latter will be treated of in the article on ANEURISM.

No parts of the human body appear to escape threatened injury more readily than arteries; none consequently are more difficult to wound. Occupying the least prominent situations in the body and limbs, the principal arterial trunks are exposed to but few of the many accidents which might befal them; and of those injuries which penetrate to their concealed courses, many more are averted by the firmness of the outer coat, or by the great elasticity of those vessels. The difficulty of opening an artery with any but a sharp instrument may be taken advantage of in surgical operations in their neighbourhood. Greater safety is secured in exposing an artery about to be tied, if the operator, like Sir Benjamin Brodie, employ a silver knife in opening the sheath; and much of the danger of wounding the obturator artery in the operation for femoral hernia averted, if, before dividing Gimbernat's ligament, the Surgeon adopt the practice of Mr. Skey, and slightly blunt the bistoury. The extent to which the quality of elasticity sometimes secures a large artery from injury is most strikingly shown in military warfare, of which the following may be quoted as examples: "In a soldier of the 56th Regiment, a fragment of shell passed through the ham, between the artery and the bone, without injuring either, although it was much too large to have done so without displacing the vessel. The man afterwards died of diarrhœa. In the 9th Regiment a similar case occurred, but in it a portion of the bone was scooped out by the missile, and the man recovered. In the 47th Regiment a large piece of shell passed through the upper third of the thigh, between the artery and the bone, but injured neither, and recovery took place."*

For these reasons wounds of large arteries are of rare occurrence, as compared with those of other soft parts, and with injuries of the bones. Indeed, the comparative rarity of these accidents, even in the practice of military surgeons, is remarkable, only fifteen cases having occurred among the 4434 wounded in the Crimea.† The fact is, doubtless, partly to be explained by the immediate fatality of the majority of these injuries. Hæmorrhage occasions many of the deaths which occur on the field of battle, and keeps out of the records of military surgery almost all the instances of wounds of the arteries of the trunk. In civil practice, however, the opportunity of ascertaining the duration of life after injuries of the larger arteries can be obtained. No. 1566 in the Pathological Series of the Hunterian Museum is a part of the thoracic aorta of a man, "ruptured transversely through all its coats, and round nearly five-sixths of its circumference. He was supposed to have lived ten minutes after a wagon passed over his body." In the same series of the Museum of the Middlesex Hospital is the lower part of an abdominal aorta cut half across by a pistol-bullet. The man was under the care of my colleague, Mr. Shaw, who had the opportunity of ascertaining that he survived the injury for an hour and a quarter.‡ A woman lately died in St. Bartholomew's Hospital, one hour after her aorta had been punctured with a needle accidentally driven into the chest. The wound of the artery opened into the pericardium, and the patient died of compression of the heart by the blood which escaped into that cavity.

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* *Medical and Surgical History of the British Army which served in Turkey and the Crimea* (Parliamentary Blue-Book, 1858), vol. ii. p. 340.

† Ibid. vol. ii. p. 257.

‡ *Transactions of the Pathological Society of London*, vol. x. p. 168.

No. 1565[a] in the Hunterian Museum illustrates, however, so remarkable a fact that it claims to be related at large, and the more especially as it is not yet described in the Catalogue of the Museum. The specimen consists of the ascending aorta of a man, laid open, and disclosing in its interior a large jagged mass of skin and subcutaneous tissue, and a hemispherical socket of lymph, adherent, like the skin, to the interior of the wall of the aorta. Out of this socket a spherical bullet, also covered with lymph, has fallen to the bottom of the vessel. The piece of skin is adherent to the left wall of the ascending aorta about an inch above the valves: the socket of lymph is fixed to the wall of the artery immediately beyond the skin. The rest of the artery is healthy. The account of the case, given by Mr. Brunton, Assistant Surgeon on board the hospital ship in the Mediterranean, and communicated by Sir Stephen L. Hammick, is to the effect, that a boat's crew, detached to cut out a vessel, met with determined resistance: amongst the wounded was "a seaman, who affirmed that a musket-ball, striking his oar, had run along it and entered his side. He lost a good deal of blood at the time, and then almost completing the third day from the injury, died.

"The post-mortem examination showed that a wound was made between the eighth and ninth ribs, and passed through the diaphragm into the pericardium, which was found full of blood, and the hole made by the shot closed up by firm coagulum. Much blood had escaped into the chest and abdomen, not only from the course of the ball, but also from the heart itself."

An open wound of the carotid or femoral artery may destroy life in a few seconds; this man, having a large aperture in his aorta, partially plugged by a foreign body, lived nearly three days. His case is a rare, perhaps an unique one, for wounds of all the great arteries of the trunk are, all but invariably, speedily fatal. The injuries of arteries, which claim the attention of the Surgeon, are almost exclusively those of the neck, the head, and the extremities. They may be thus arranged:

1. An artery may be seriously injured by a violent blow, although it present no trace of laceration of any of its coats. The only consequence of the injury is a narrowing of the calibre of the stricken part of the vessel; but that narrowing is permanent, and may seriously impede the current of blood to distant parts of the limb. It is probably not sufficient of itself to occasion gangrene,

but it will concur with other injuries, in themselves also insufficient, to produce that result. I extract the facts of the following case from the very valuable *Surgical History of the British Army*, already referred to.

" P. R., aged 21, was wounded on the 8th of June by the explosion of a shell, which produced a lacerated wound of the inner ankle of the left leg, laid open the joint, and exposed, but did not fracture, the tibia. He had also received a second wound, by what was supposed to have been a canister shot, through the upper part of the thigh of the same side, in the course of the vessels, neither of which, however, appeared to have been wounded. On the 16th of June, incipient gangrene of the foot had set in, but the system was but little affected by it. The limb was amputated immediately below the knee by a small anterior, and large posterior flap, and the stump lightly dressed. On the 18th, symptoms of gangrene appeared in the stump, showing themselves first in the posterior, and then extending to the anterior flap. On the 19th the gangrenous inflammation showed some inclination to stop immediately below the wound in the thigh on the inner side, but it had extended on the outer too high to allow of any thing short of amputation at the hipjoint. On the 20th it reached the walls of the belly, and the patient died at 2 P.M. on that day.

" On a post-mortem examination of the body, the ball was found to have passed through the thigh internally to the sheath of the femoral vessels, which it had grazed, but not opened. The artery at this point was slightly contracted for about an inch of its length, but pervious: it contained no coagulum, and beyond the contraction showed no marks of inflammation. The vein, however, was not only slightly contracted, but its internal surface was inflamed and filled with partially organised lymph, as far upwards as the entrance of the deep iliac vein, and downwards for about two inches from the wound. Its course was thus entirely sealed."*

The contractility of arteries seems to be very considerable, and to exert a most important influence upon their injuries, as well as on their functions. Not only do these vessels adapt their calibre from time to time to the size of the stream which passes through them; but under extraordinary circumstances they put forth a muscular effort, by which they are nearly, or even completely, closed. The arterial trunk in an amputated limb may be seen to have contracted to one half of its former area, if examined a few minutes after the operation. John Hunter saw the carotid artery of a living ass diminish in size upon its mere exposure to the air. The same power permanently reduces the calibre of a tied artery between the ligature and the next branch above it, and the contraction in that case takes place, whether the unused part of the artery still pulsate with fluid blood or be filled with coagulum. The ductus arteriosus, probably, and the umbilical arteries are for the most part closed in the same manner, the artery first contracting, and then closing either by the coherence of its own inner membrane, or by the intervention of some new material derived from the blood, and capable of uniting with the shrinking tissues of the vessel. The rapidity of this contraction and its extent are well seen in the very extremity of a cut or lacerated artery, the stream of blood from which gradually lessens, and at length ceases, as the coats of the vessel approximate and close its orifice.

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* Vol. ii. p. 343.

These instances are unquestionably vital contractions of the artery, effected probably by its middle coat, and are not due to inflammation. They occur sometimes too rapidly to be attributable to that disease, and are unaccompanied with any other indication of it. It is to be observed, moreover, that an inflamed artery, if altered at all in its calibre, becomes rather dilated.* Its area might be intruded on or compressed by inflammatory products, but the artery itself would not contract. It is therefore probable that, in the following instances, the two conditions of vital contraction and inflammation were combined together as results of the same injury.

A ball passed between the popliteal artery and vein of a soldier without opening either, and gangrene of the limb destroyed life on the sixteenth day. The vein was found blocked with coagulum. The coats "of the artery were not destroyed in substance, although bruised; it was at this spot much contracted in size, and filled above and below by coagula."†

A similar occurrence was observed in the Crimea,‡ where, when sloughing had attacked a large wound of the arm, occasioned by a fragment of an exploded shell, arterial hæmorrhage took place, and it was found that the brachial artery had sloughed to the extent of one-eighth of an inch of its length and one-third of its circumference. In the operation of placing and tying a double ligature above and below its bleeding aperture, the vessel was found to be so much smaller than usual that a high division of it was suspected. It had, however, contracted in the vicinity of the injury and slough.

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* Rokitansky, *Path. Anat. Syd. Soc.* vol. iii. p. 254.

† Guthrie *on Wounds and Injuries of the Arteries*, 1846, p. 22, Case 24.

‡ *Surgical History of the British Army*, &c. vol. ii. p. 342.

In all the remaining examples of injuries of arteries, one or more of the coats, or parts of the coats, of the vessels have been found to be divided: the varieties of these accidents are numerous, and they entail such various consequences that they must be separately related.

2. Considerable violence sometimes lacerates the inner coats of an artery, without tearing through the stronger outer coat. Neither in this injury, nor in that last described, is there any hæmorrhage from the vessel; the consequences of the injury develop themselves at a later period of the case, in mortification, or other result of a deficiency of arterial blood in the parts beyond the injury of the vessel. In the examples of this injury which have fallen under my observation, the inner coats have been separated from the cellular around the whole circumference and for some distance of the length of the artery, but not at the lower margin of the rent; the upper and separated portion has then been inverted by the force of the arterial current, and has been found almost or completely blocking the lower and uninjured part of the artery. The fact that the lacerated coats are so commonly found to adhere by their *lower* margin suggests the possibility of their separation from the outer coat not being the immediate effect of the injury, but of having been continuously effected by the force of the arterial current after their first laceration. And the phenomena observed in the so-called 'dissecting' aneurism support this suggestion. The inner coats are in that accident sometimes separated from the outer throughout all the large arteries of the trunk; and Rokitansky describes one instance in which a portion of the inner coats of the arch of the aorta was driven onward in the course of the arterial current, and lay, rolled up into a tube, within the left subclavian artery. It is, nevertheless, usually clear from the appearance of the parts in the injury under consideration that the whole laceration was produced at once by the external violence.

A man was admitted into the Middlesex Hospital under the care of Mr. Shaw, and lived three hours after having been struck by the shaft of a vehicle in the right iliac region. The external injury was slight, but the lower limb of that side was without pulsation, motion, or sensation. The intestines were not injured; but the psoas muscle was much torn, the costiform processes of the fourth and fifth lumbar vertebræ were fractured, and there were large quantities of blood in the peritoneal cavity. On examining the vessels, a rent of an inch in length was discovered in the inferior vena cava, and the inner coats of the right common iliac artery were severed from the outer, and inverted downwards within the lower part of the artery.

The following case illustrates several points, besides the blocking of the artery and vein, and the consequent gangrene. A muscular man, aged sixty, was brought into the Middlesex Hospital in 1855, intoxicated, and injured by an omnibus, which had just run over him. His right femur was broken and comminuted in its lower third. The integuments were slightly bruised, and there was a small wound in them communicating with the fracture; but no other external injury. The internal structures, however, were much lacerated, and the limb could be moved in any direction at the seat of fracture. The hæmorrhage was moderate and venous. No pulsation could be felt beyond the knee; the limb was pale and cold, and entirely without feeling about the foot. No persuasion could induce him to submit to amputation; but the next morning, twelve hours after the accident, I received an urgent message from him, requesting me to remove the limb.

I found him pale and with an anxious countenance, vomiting occasionally, with his pulse feeble and at 128, and complaining of pain in the limb. His voice was still hearty and strong. The leg and foot were cold, and mottled with stagnant blood; the condition of the injured part had not changed; the thigh above it was swollen and tender. Under these circumstances, I endeavoured to dissuade him from undergoing the operation; but upon his eagerly pressing to know if there was any possible chance of recovery, I could not deny that chloroform (of the action of which under such circumstances we were then ignorant) might neutralise the shock of the amputation; and that if he lived through it, he would have lost the depressing influence of his dead limb, and might rally. It was an experiment which I believed him to have a perfect right to try under such desperate circumstances. He decided immediately to lose his limb.

He first took repeated small quantities of brandy and a dose of opium; but as he became feebler rather than stronger, I did not further delay in operating. The chloroform at first excited him; as he became quieter, the pulse failed, and I amputated the thigh high up. The pulse returned, and he breathed regularly until nearly all the vessels (which bled as usual with arterial hæmorrhage) were tied. Then he had a convulsion, and rigidity of the muscles confined to the right side. Paleness and stertorous breathing succeeded, and from that time he breathed regularly and had pulse again for about three minutes, when he died. Dashing cold water in his face made him gasp, but did not restore him beyond the moment; and galvanism, which was employed about his chest before he ceased to live, made no difference in his symptoms.

At the post-mortem examination, the brain was found smelling of alcohol, not of chloroform, and wasted; the gray matter thin and pale, the arachnoid opaque, and the spaces beneath it full of fluid. The heart was large and firm; both its ventricles were hypertrophied. Small portions of its muscular substance were pale and fatty, and there were slight ecchymoses under the endocardium in the left ventricle. The aorta was roughened by atheromatous deposits, and much dilated. The lungs were emphysematous, moderately congested, and very œdematous at their posterior parts. The blood showed itself on the surface in a large bruise at the back of the left thigh, and in the ordinary sugillations at the back of the body; but all the internal organs, except the heart, contained less than their usual quantity of blood. All the chambers of the heart were abundantly filled with clotted blood, and that in the left ventricle had separated into fibrin and crassamentum. The soft parts of the limb were extensively lacerated; the sciatic nerve was isolated for four inches of its length, and ecchymosed; three inches of the popliteal artery and vein were separated from the other soft parts, and both vessels for the same distance were blocked with coagulum. The coagulum was in one spot adherent to the artery, and at that spot the internal coats, in their entire circumference, had been torn through, separated for three-fourths of an inch from the outer coat, and turned down within the lower part of the vessel, the canal of which was thus completely plugged. The external coat of the artery was entire, though slightly ecchymosed.

The division of the two inner coats and the obliteration of the canal is the amount of injury aimed at in *applying a ligature upon an artery*. The earlier operations of this nature were attended with an amount of violence to the artery, hardly less than that described in the last case. The vessel was separated forcibly and extensively from its sheath, and unnecessarily lacerated with clumsy tapes and instruments. But modern surgeons disconnect the artery as little as possible from its sheath, tie it with a slender and firm ligature, and find the consequent mortality much reduced. The following are the conditions of failure and success in the operation, so far as regards the artery and its collateral branches.

The ligature, when well applied, cuts the two inner coats, tightly constricts the outer coat, and stops the current of blood along the vessel. Within a few hours after the operation, there forms above the ligature a coagulum of blood, which usually fills the entire calibre of the tube, and adheres to the lacerated surface within it. Being disturbed at its upper part, however, by the arterial impulse, which alternately lengthens and shortens the vessel, the coagulum is there less complete, and narrows to a point. It varies much in length, and therefore in form, in different cases. It may not adhere any where, even by its lower end. It may not exist at all, and is not unfrequently absent from the portion of the artery which is below the ligature. I have, however, found the common iliac artery quite filled with coagulum, to either extremity, from a ligature applied at the middle of its course. That the plug is not without advantage is manifest, since it secures a certain amount of repose to the artery at the part which has been tied; and if the ligature be removed before the consolidation of that part, the permanent plugging of the artery must in great degree be due to the coagulum.* That the plug, at the same time, is not indispensable for the closure of the vessel, appears from that process being sometimes perfected without a plug. An uncertain amount of contraction of the artery takes place, but it is much marked only above the ligature. Below the ligature the artery sometimes presents neither contraction nor clot.

The efficient process, by which the artery is eventually closed, meanwhile goes on at the tied portion. The inflammation set up by the operation and by the presence of the ligature occasions an effusion of plastic lymph, which coheres within the vessel with the lacerated coats, and externally accumulates around the artery and along its sheath. Penetrating also the very substance of the external coat next the ligature, it unites that coat with itself into one consolidating mass. From the outer side of this mass the vessel casts off the sloughing constricted part of its external coat, the separation of which leaves the vessel divided, yet with each extremity firmly sealed, even when unprotected above by a conical clot. The final changes in the artery are, the obliteration of its canal from the closed extremities to the next pervious lateral branches, and the conversion of its tissue into a fibroid cord. When an internal plug is present, it probably takes part in producing the former of these changes, and adheres by the intervention of a new albuminous material formed from the blood, with the original lining membrane of the artery. The vessel may, however, close by means of the same material without any plug. The contraction and final conversion of the coats into a fibroid cord follow yet more slowly upon the cessation of the function of the artery.

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* *Med.-Chir. Trans.* vol. ix. p. 405.

The process just described is liable to failure in various ways, which occasion dangerous or fatal consequences. The failure of the process most commonly shows itself by *hæmorrhage* at the seat of operation about the time of the separation of the ligature. Probably this rarely arises from the absence of a central clot in the artery, since the repair may be completely effected without it. There appear to be three modes in which hæmorrhage is brought about: a partial or entire absence of contraction of the artery, a defect in the quantity or plastic character of the lymph, and ulceration of some part of the vessel. The first only is of local origin; the last two depend upon constitutional causes, or both perhaps upon the same cause. It will be seen, by referring to the remarks on ATHEROMA of the arteries, that vessels in that condition are incapable of contraction. The ligatured part of such an artery is consequently exposed to the full force of the current of blood, and needs for its security what rarely coincides with such disease, viz. a very vigorous process of repair. When the ligature becomes loosened from such an artery, the blood bursts through the weak barrier at its extremity, and not uncommonly a fatal result follows the disaster. That the absence of this contraction has something to do with the occurrence of hæmorrhage from a tied artery is rendered further probable by the fact, that both are most frequently observed below the ligature. The other causes of hæmorrhage appear to be constitutional. Arteries may be found in museums with but a very small and inadequate quantity of lymph about the ligature. It has been formed in very small quantity, or, having formed, has failed to become organised and to consolidate. When the ligature loosens, the extremity of the vessel is found to be unclosed. In some of these specimens it is difficult to be certain whether the ragged orifice, through which the fatal hæmorrhage occurred, was a laceration by the force of the blood, or an ulceration which, in loosening the ligature, also opened the artery.

Although it is certain that the process by which a tied artery heals is the union of the lacerated parts by lymph, it cannot be thence concluded that the presence of a clot is a matter of no importance in respect to the accomplishment of the process. In any artery it must secure a certain amount of repose; in the larger it seems to be indispensable. Small arteries scarcely ever bleed after ligature, whereas in the innominata the process of repair has never been known to be accomplished. The small arteries, having a less vehement impulse, and a thicker middle coat in proportion to the area of their tubes, may close without clot; it is, however, observed that hæmorrhage at the seat of ligature does not altogether, or chiefly, arise from the large calibre of the artery, but is also in part determined by the proximity of collateral branches to the ligature. On comparing the per-centage of secondary hæmorrhages after ligature of the common carotid or external iliac arteries, vessels which run a long course without giving off branches, with that which succeeds the same operation on arteries placed in the opposite condition, such as the common femoral, the advantage is found to be greatly on the side of the former. The artery gives way in 6½ per cent of the operations on the first vessel, and in 6 per cent of those on the external iliac, while the frequency of that event in the instance of the common femoral mounts up to 56 per cent.*

The laceration of the inner coats of an artery, instead of being repaired, is sometimes followed by the formation of an *aneurism.* Possibly many aneurisms, which are attributed to previous injuries, may arise in this manner, though the subsequent changes at the part obscure their mode of origin. Though a rare, it is an occasional, event after the laceration by ligature. In a case reported by M. Delacour,† of Rennes, an aneurism formed on the anterior tibial artery after an amputation of the leg, and could be seen enlarging on the face of the stump. Repeated hæmorrhages took place from it between the thirteenth and thirty-eighth day after the amputation, which were arrested on the latter day by the ligature of the femoral artery. The patient eventually recovered, though not without hæmorrhage from the wound of the operation in the thigh, as there had previously been from the wound of the compound fracture, on account of which the amputation had been originally performed. Warner, in his *Cases of Surgery* (p. 50), mentions a yet more remarkable instance of this occurrence. He observed an aneurism of the brachial artery to form in the stump of an arm which he had amputated a few days before. He applied a ligature upon the vessel "above the upper extremity of its distended coats," and cured the aneurism; but a second aneurism formed above the ligature. A third operation was attended by the appearance of a third aneurism in the same relation to the ligature, for which he tied the artery again; but as on this occasion he performed Hunter's operation, not Anel's, tying the artery near to the axilla, he succeeded in saving his patient. It is probable that in these cases there existed a previous disease of the coats of the arteries in the situations selected for the ligatures. The small number of the recorded cases of this nature corresponds with the rarity of their occurrence.

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* Porta, *delle Alterazioni Patologiche delle Arterie,* 1845, p. 136. Broca, *des Anévrismes,* p. 604.

† Broca, *des Anévrismes,* p. 39.

The injuries of large arteries under our present consideration are rarely uncomplicated. Most commonly the adjoining vein is wounded or bruised at the same time as the artery, and the sudden or even the gradual stopping of its circulation which ensues, almost necessitates *gangrene* of the limb.* Nerves, as well as other soft parts, may also be torn or bruised, and either numbness or painful exaltation of the function of the nerves may follow their injury. Broca† mentions an instance of the latter kind as *inflammation of a nerve*, occurring consecutively upon an operation for tying an artery. The symptoms commenced nineteen days after the brachial had been tied at five fingers' breadth above a traumatic aneurismal varix in the bend of the arm. The first indications of the neuritis were, painful sensations in the forearm and hand, which were succeeded by sharp pains in the three and a half fingers supplied by the median nerve. The pains were increased by pressure on the wound, but not on the fingers. They diminished in five days, and were followed by numbness, and at length by almost complete loss of feeling, in precisely the situation which had previously been painful. In ten days more, the natural sensibility had returned. Phlebitis and fatal pyæmia are more common results of the operation of tying an artery.

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* An example of an injury of this kind, in which gangrene did not ensue, is recorded as having occurred in the practice of Mr. Carsten Holthouse, at the Westminster Hospital. Twelve days after the infliction of a punctured wound on a man's thigh, Mr. Holthouse cut down, and found the femoral artery opened in Hunter's canal. He tied both ends of the vessel. At the same time he saw an opening in a large vein adjoining the artery, from which venous blood escaped in great quantity. This hæmorrhage was arrested by plugging; and, after the sloughing of a small portion of skin on the outside of the foot, the man recovered. Eight months afterwards, Mr. Holthouse found the limb useful, the tibial artery beating on the foot, and the internal and external saphena veins swollen. In the absence of further evidence, this case may be regarded as one in which the occurrence of contemporaneous obliteration of the femoral artery and vein, not followed by gangrene of the limb, is highly probable. *British Med. Journ.*, 1859, pp. 364, 954.

† *Des Anévrismes*, p. 479.

The effects of obstruction of arteries upon the parts of the body which they supply with blood have already been partly stated. In most instances of the sudden division or obliteration of the principal artery of an extremity, more or less gangrene ensues. The whole safety of the limb in this respect depends upon the reëstablishing of the arterial circulation through the enlargement of the collateral channels, and, as that is a slow process, the limb often dies before it can be completed. For the same reason gangrene is a less frequent result of the obliteration of the artery in the shorter and more vigorously nourished upper limb than in the lower. It is also more apt to occur when particular portions of the main artery are obstructed. Thus a ligature or wound of the common femoral is more often followed by the death of the leg, not only than when the same trunk is blocked up below the origin of the profunda, but than when the external iliac is obstructed. The collateral circulation is then insufficient to keep the limb alive without the aid of the epigastric and circumflex ilii arteries. A similar, but a less serious, deficiency of collateral vessels is met with at the upper part of the brachial artery. In all cases of wounds in the neighbourhood of large arteries, the attention of the surgeon will of course be directed to the state of the circulation. If the pulse have ceased beyond the injured part, the limb will become cold and pale, and care must be given to keep it warm, and to avoid all bandaging and all malposition by which the establishment of the collateral circulation might be interfered with. The appearance of heat and redness on the integuments may be hailed as a sign that the blood is traversing the smaller vessels towards the distant parts of the limb; whilst increasing coldness of its surface, a mottled appearance, delay in the return of blood to a part which has been emptied of it by pressure, slowness in the refilling of superficial veins after the blood has been carried along them by the finger, or in their filling when compressed at the higher parts of the limb, all indicate a languid state of the circulation and imminent mortification.

Even when the collateral circulation acquires a vigour and amount sufficient to ensure the life of the limb, it is rarely the case that the latter regains its powers in all respects. A limb in which the principal artery is obliterated generally remains for years in a state of feebleness and impaired nutrition. It is weaker and, unless it be œdematous, smaller than its fellow; it is easily chilled, and may be permanently colder than natural. The sudden loss of the artery is sometimes never repaired by the establishment of a vigorous collateral circulation, and the limb, though not dead, remains almost incapable of muscular exertion, emaciated, cold, and with its integuments dry and shrivelled. But if the smaller arteries have enlarged before the obliteration of the main trunk, as is usually the case when an aneurism has existed for some weeks or months before the ligature of the vessel leading to it and to the limb, the latter may regain much of its healthy powers. I tied the superficial femoral artery for an aneurism which had been known to exist in the ham for eight weeks, and had that morning burst into the knee-joint. Thirteen weeks after the operation, the man was able to walk from Hampstead to the Middlesex Hospital; the leg and foot were œdematous, and the whole limb, below the site of the operation, larger than its fellow. I examined the lower limb of a healthy man, whose femoral artery had been tied by Mr. Quain nine years before. The circulation was so far reëstablished that the anterior tibial artery could be felt beating on the instep. Yet the ankle was œdematous, and the posterior tibial consequently could not be felt. The whole limb was smaller and weaker than the other, and liable to become cold. The foot was bent inwards as in slight club-foot, and the integuments were dry and scurfy.

3. There remains one other mode in which an artery has been known to be injured without the entire division of all its coats. It is that in which the vessel is cut or torn through its external, and more or less of its middle coats, whilst a thin, undivided inner portion still preserves the integrity of the canal. No hæmorrhage takes place at the time of such an accident. In experiments on animals, a great portion of the coats of an artery may be dissected off, and the extremely thin membrane which remains will bear, without tearing, the impulse of the arterial current within, and also firmly heal over.* A result so favourable cannot, however, be expected to follow the same kind of injury in the human subject. The following case is an instance of the injury and its result:

"A gentleman, in a moment of great anxiety of mind, cut his throat with a razor, and fell bathed in blood. The bleeding was arrested by thrusting sponges into the wound. The cut had laid bare the left carotid, and wounded the internal jugular vein, from which the principal bleeding came. The opening in the vein being distinct, I passed the point of a tenaculum through the edges made by the cut into it, and, drawing them together in this manner, passed a single silk thread around, so as to close the opening without destroying the continuity of the vessel. The ends of the ligature were cut off close to the knot. The carotid was then seen close to the vein, having a transverse mark or cut upon it, which did not appear to penetrate beyond the middle coat; and, after due consideration, it was presumed that this wound might heal, without requiring a ligature to be placed upon the artery. On the eighth day, arterial hæmorrhage took place; and on opening the wound, it came evidently from that part of the artery which had been cut. I placed a ligature upon the common carotid immediately below this opening, but the flow of blood was scarcely diminished in quantity by it, in consequence of the reflux from the head. On attempting to apply another ligature above the opening, I found, as I had before suspected from the situation of the wound, that it was immediately below the division of the common carotid into the external and internal carotid arteries. The hæmorrhage ceased on placing a ligature on the external carotid, above the wound in the artery, and, as the patient was greatly exhausted, I refrained from tying the other. The bleeding did not return, but he died the next morning from weakness.

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* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge,* vol. i. p. 144.

"On examination after death the internal jugular vein was found pervious, and without a mark indicating where the ligature had been applied. The origin of the internal carotid was filled for about a quarter of an inch with a soft coagulum of blood."*

It is plain upon the face of this candid record of fact, that it may be indispensable to tie an arterial trunk at the time of the accident, although there should be no hæmorrhage to indicate the necessity of so doing. After this case of Mr. Guthrie's, no artery similarly injured may be left without the security of two ligatures.

4. A gush of blood issues from a recent wound. Bystanders fly hither and thither for bandages, but leave the life-blood to escape. If a surgeon is at hand, he instantly puts his finger on the bleeding point, and stops the flow. A stream of questions rushes through his mind, which he must prepare, or be prepared, to answer. Whence comes the blood? From a vein or an artery? From a large or a small artery? From a wound of the vessel which is, or is not, capable of closing spontaneously? How is the flow to be stopped? Must the artery be tied? If so, where may the ligature

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* Guthrie, *Wounds and Injuries of Arteries*, 1846, p. 78, case 123.

be applied upon it? Is one ligature sufficient? Are two enough? Further questions arise as to the best direction in which the incisions may be made, and on other proceedings required by the special circumstances of the injury, in the operation of tying the vessel.

Both caution and experience are necessary in estimating hæmorrhage. All persons are apt to be misled by its violence and rapidity into attributing the bleeding to a larger vessel than has actually been wounded: it is even possible for a moment, when bleeding has ceased, to mistake for present hæmorrhage the mere overflow of blood which is pressed out of a wound by some movement or handling of the injured part. However abundant may be the hæmorrhage from a vein, the colour and steady current of the blood at once distinguish it, and it is always readily controlled. The numberless small vessels of a large recently cut surface bleed smartly; the even current and dark tint of the blood, however, cannot be confounded with its bright colour and jetting flow when an artery of considerable size has been wounded. More difficulty is experienced in determining the source of the bleeding when it is clearly arterial. That which is relatively a large wound in an artery of moderate size, may furnish a hæmorrhage indistinguishable from that of a main trunk in which a comparatively small opening has been made. The perplexity is the greater the nearer the course of the wound approaches the known situation of a great artery. It is also alleged that small arteries divided near or at their origins from large trunks bleed with a severity quite disproportioned to their size. It is certain that wounds of them have been mistaken for wounds of a trunk-vessel.

When the surgeon is satisfied that the bleeding from a deep wound is arterial, it is not indispensable that he should tie the vessel. The smaller arteries are much more numerous than the larger, and, in the great majority of cases, even arterial hæmorrhage ceases without the application of a ligature. The flowing blood coagulates around and upon the orifice of the vessel, which then heals. Some wounds of even a large artery may close, but it is impossible to depend upon their doing so spontaneously. Many lancet-wounds of the brachial artery, for instance, heal under pressure. Mr. Guthrie mentions the case of a wound made by a pike in the axillary artery which healed without surgical interference. The life of Larrey's patient, Pierre Cadrieux, appears to have been saved by the singular circumstance that the subclavian vein was also pierced by the lance which wounded the artery. The blood from the latter vessel, when restrained from passing through the external wound, escaped into the vein, and was thus saved to the system until the wound healed.*

Such cases as the following may illustrate the occurrence of hæmorrhage, controllable without the application of a ligature, as well as some of the means which may be adopted in similar circumstances to stop it.

"An officer, aged twenty-eight, was struck by a musket-bullet in the back of the neck. It entered near the median line, passed upwards and to the left, and was cut out immediately below the zygomatic angle of the malar bone. There was considerable pain on moving the jaw; and on introducing the finger into the mouth, the teeth were found to be irregular and loosened. The ramus of the jaw, or its condyloid process, appeared to have been injured, and probably the zygomatic process of the temporal bone. No untoward symptom occurred until the twelfth night, when he awoke from sleep, and found himself bleeding from the wound in the nape of the neck. After about six ounces of arterial blood had been lost, the hæmorrhage ceased spontaneously. A recurrence of bleeding to nearly the same amount took place thrice within the next three days. The blood seemed to well up from a deep source, and was restrained by a very little pressure. As oozing continued, the wound in the nape of the neck was plugged with lint steeped in tincture of matico, and bandaged. Occasional oozing from the wound in the cheek continued during the day. Sumat plumbi acet. gr. jss. c. opii pulv. gr. ss. tertiâ quâque horâ. From this time the bleeding is said to have ceased."†

"A private soldier, aged twenty-six, was struck by a grape-shot, which split his cheek extensively, fractured the superior maxillary bone, and lodged in front of the vertebræ. A portion of the superior maxillary bone, with all the molar teeth and palatine plate, were displaced into the mouth, and found to be lying on the tongue, preventing the patient from closing his mouth. The powers of deglutition and articulation were completely gone, respiration was seriously impeded, and saliva mixed with blood flowed from the mouth. The wound in the cheek was enlarged, the displaced bones, and portions of the malar bone, floor of the orbit, and ascending process of the superior maxillary bone were removed, and the ball extracted, the vast wound lightly plugged, and the parts brought together. No bad symptom came on until the morning of the fourth day, when secondary hæmorrhage to some extent occurred from the back of the palate. On removing the lint and the clot of blood, no bleeding vessel could be detected. The wound was again plugged with lint dipped in tincture of matico, and ice was kept applied to the palate. Whenever the ice was removed, hæmorrhage returned, and it was therefore kept constantly renewed for six hours. The bleeding returned when he attempted to take food, and it was again checked with ice. After this he recovered."*

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* Larrey, *Clinique Chirurgicale*, vol. iii. p. 139.

† *Surgical History of the British Army*, &c. vol. ii. p. 307.

"A musket-ball entered immediately behind the trochanter major of a soldier, passed downwards, forwards, and inwards, and came out on the inside of the anterior part of the thigh. The ball could not have injured the femoral artery, although it might readily have divided some branch of the profunda. Several days after the receipt of the injury, I saw this man sitting at night on his bed, which was on the floor, with his leg bent and out of it, another holding a candle, and a third catching the blood which flowed from the wound, and which had half filled a large pewter-basin. They seemed to think it would stop in due time, having bled once before during the afternoon. I placed a tourniquet, with a thick pad, as high as possible on the upper part of the thigh, and requested the officer on duty to loosen it in the course of an hour; which was done, and the bleeding did not recommence. The next day I placed the patient on the operating-table, removed the coagula from both openings, and tried to bring on the bleeding by pressure and by moving the limb; it would not, however, bleed. As there could be no other guide to the wounded artery, which was evidently a deep-seated one, I did not like to cut down into the thigh without it, and the man was replaced in bed, and a loose precautionary tourniquet applied. At night the wound bled smartly again, and the blood was evidently arterial. It was soon arrested by pressure. The next day I placed him on the operating-table again, but the artery would not bleed. This occurred a third time, and with the same result. The bleedings were, however, now almost immediately suppressed, whenever they took place, by the orderly who attended upon him, care having been taken to have a long thick pad always lying over the femoral artery, from and below Poupart's ligament, upon which he made pressure with his hand for a short time. The hæmorrhage at last ceased without further interference, and the man recovered."†

It is clear from these and many other cases that hæmorrhage, even of an alarming character, may cease; and the rule generally followed amongst surgeons in all early cases is to employ graduated pressure, cold, astringents, or an elevated posture, as may be most suitable in the particular circumstances; and to assist these various direct means, when practicable, by the addition of indirect compression. It may be said that all completely divided arteries, not being trunk-vessels, if they are accessible to these modes of treatment, may be closed. But when bleeding is severe, it may be doubted whether the treatment by the plans above enumerated, though capable of effecting a cure, be, after all, preferable to the ligature; and, if the vessel be easily accessible, few surgeons would hesitate to tie it. It is to be remembered that the bleeding may be renewed from time to time, that the soft parts which are subjected to pressure may slough, and must necessarily undergo a process of inflammation, by which they become matted together, and for a long time, or permanently, useless. The consequences in the palm of the hand *e. g.* are most serious. Moreover, if the wound be in an arterial trunk, and be capable of spontaneous closure, no eventual advantage is gained by the risk run in trusting the wound to a spontaneous cure, since by it, as well as by the ligature, the artery becomes obliterated.

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* *Surgical History of the British Army*, &c. vol. ii. p. 306.

† Guthrie *on Arteries*, 1846, p. 69.

When hæmorrhage recurs after having once ceased, the surgeon will judge by its severity, both absolutely and comparatively with the first bleeding, as to the propriety of cutting down and tying the artery. The operation at this period is likely to be more difficult than at first, in consequence of the changes which have meanwhile occurred in the parts concerned. For the same reason, the bleeding is less likely to stop than it was at first; and, whilst a cure may possibly be obtained, it is again better practice to secure the vessel by operation. An incised wound entails less mischief than one around which the tissues are consolidated by the action of pressure and astringents; to say nothing of the freedom from mental disquietude enjoyed by both patient and surgeon, and the security against further loss of blood afforded to the former by the ligature.

The hæmorrhage is, in some instances, quite disproportionate to the size of the bleeding orifice, or at any rate to our estimate of its importance. Mr. Guthrie mentions that he has, more than once, known the femoral artery, punctured by a tenaculum in an amputation, to bleed so uncontrollably as to require a ligature. A more serious consequence of this fact has sometimes happened when, the power of the artery having been misapprehended, a trunk-vessel has been needlessly tied. Thus the external iliac artery has been tied for a wound of a small and superficial branch of the femoral artery.

There are certain wounds of arteries which are probably always incurable by local processes of repair, however aided. I know of no instance of hæmorrhage finally ceasing so long as any foreign body remained in the opening of the artery. I have known a fatal result ensue upon the failure to extract a foreign body so placed. A fragment of a tobacco-pipe, entering by the mouth, pierced the anterior pillar of the fauces on the right side, and lodged. Hæmorrhage took place at the time, but it stopped of itself; and I saw the young man, six or seven hours afterwards, pale, and with one tonsil swollen near the wound. I could not see or feel the fragment of pipe, nor could I detect it in the wound with a probe. A large swelling formed in the upper half of the neck, which on the seventh day suddenly began to pulsate, while arterial blood issued copiously from the mouth. The carotid was tied below the swelling. The operation was immediately followed by paralysis of the left extremities, and it persisted. On the thirteenth day after the accident, bleeding suddenly recurred through the mouth, and was immediately fatal. At the post-mortem examination, the lower end of the fragment of pipe was found lying in a hole at the top of the common carotid, surrounded with buff-coloured lymph, and with a carotid branch on either side of it. The wound of the vessel could not possibly have closed. Although the primitive carotid was filled with clot from near the wound down to the ligature, the external and internal carotids were empty. There were also several fœtid abscesses in the right hemisphere of the cerebrum. Mr. Vincent, in publishing this case in the twenty-ninth volume of the *Medico-Chirurgical Transactions*, remarked that, if the piece of pipe had been discovered and extracted through the mouth, fatal hæmorrhage would in all probability have occurred, as he believed to have happened in a previous and similar case. The alternative of leaving it in the wound was only better inasmuch as he did not die so soon. To have extracted the piece by an incision in the neck, through the mixed mass of lymph, serum, slough, and blood, which lay between it and the skin, and to have tied the vessel where it had been wounded, was, I believe, impracticable.

Neither does an artery heal when the wound in it, whether longitudinal or transverse, is an extensive one. When there is a long rent in an artery, or a division of it half across, its retractile and contractile powers tend to keep open and enlarge the wound both in length and breadth. Neither the upper nor the lower end of an artery so wounded can completely contract; no fibrinous plug closes the wound itself; and if the artery be large, or if it lie in loose tissues, which afford no support to the amount of pressure requisite for its obliteration, the bleeding may be fatal. The temporal artery thus wounded may be as safely treated by a firm compress as by the division of the vessel. The following case was not so manageable.

A healthy woman, aged thirty-eight, broke a chamber-vessel by her weight, and was brought to the Middlesex Hospital with a bleeding wound in the nates of the right side, inflicted by one of the fragments.* The wound was situated by the side of the coccyx, parallel with the mesial line, and an inch and a half in length. It had divided the lowest fibres of the glutæus maximus and greater sacro-sciatic ligament, separated the right extremity of the first bone of the coccyx, and passed deeply into the pelvis. Arterial blood issued from it at first in considerable quantity, and then ceased to flow; but it burst forth again from time to time, and the wound was enlarged at both ends with the object of finding the vessel. Nothing could be reached, however, but a large cavity in the pelvis, from which blood welled out in considerable quantities. The wound was therefore plugged, and blood ceased to flow. Again, however, the bleeding returned. On the eighteenth day she was greatly exhausted, restless, panting, pale, and pulseless. She did not lose consciousness, and she desired to have her urine drawn off. While in this state she suddenly died.

Post-mortem examination. The surface of the body was extremely pallid; the right labium swollen. The external wound in the right nates opened within the pelvis into a cavity nearly large enough to contain a child's head. The vagina and rectum were displaced to the left side; the bladder, the uterus, and the right ovary had been driven upwards into the abdomen. The pelvis, and the coats of the rectum and vagina, were full of blood, and the extravasation reached upwards behind the peritoneum to the diaphragm on the left side, and to the kidney on the right. The principal branches of the internal iliac artery were unhurt; but the internal pudic, before leaving the pelvis, passed along the side of the cavity, and was there covered only by some recently formed lymph. On removing the latter, the vein was found to have been cut completely across, and the artery in the same line of incision was half divided. The wound in the artery gaped widely, and there was no clot in any part of the canal of the vessel. The heart was flabby, and contained in its right side a small loose coagulum mixed with air-bubbles. On the left side was a smaller clot, less loose, and partly fibrinous.

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* The hesitation of the patient, and other circumstances, raised a suspicion that she had been stabbed. I may, however, mention that a lady of rank is reported to have been found dead from sudden hæmorrhage after a similar accident.

Wounds of this form in larger arteries, when left to themselves, are equally and more rapidly fatal: death takes place before the formation of any fibrinous plug. The possibility of the existence of such a wound confirms the propriety of the advice, that the ligature should, as a rule, be preferred to all other measures for arresting recurrent arterial hæmorrhage.

When an artery is *completely divided*, a great difference in the effects is observed according to the manner in which the injury occurred. There is rarely any great hæmorrhage from a brachial or femoral artery when a limb is torn off by machinery; whilst when cut across, an artery bleeds most profusely. In the latter case, the open mouth of the artery pours forth blood until the patient dies, or the opening spontaneously contracts, or is closed by an external plug; in the former, the external coat is dragged out into a long slender point, even an inch or two beyond the spot at which the inner coats are torn. Arteries completely divided on the battlefield, bleed, or not, as their injury approaches one or other of these forms. They may be cut by the edge of a fragment of shell, or of bone, or by a split ball, and may bleed profusely; or they may be roughly but transversely divided by the direct blow of a musket-ball, and bleed until stopped by the formation of an external coagulum: contraction is observed in the uninjured part of the artery, above its jagged extremity, but does not of itself suffice to close the canal of the vessel. The laceration of an artery which takes place when it is violently stretched in a longitudinal direction, as when a limb is torn off, is not attended with hæmorrhage. The principal trunk hangs out of the wound, diminishing almost to a point, and pulsating to its very extremity. In such cases the state of the artery is often but of secondary importance; the treatment is determined by the amount of other injury which the patient has sustained, and by his general condition.

An artery of moderate size, when completely divided, usually ceases to bleed, and no hæmorrhage is renewed from either end of it. There are, however, instances of great importance on record, in which such vessels by continuous bleeding have thrown out a very great quantity of blood. Branches of the axillary artery sometimes bleed thus largely into the loose tissues of the axilla; and as the enormous and tense swelling presents no pulsation, it might be supposed that the injured vessel was a vein.* Mr. Liston has recorded an example of such a wound of a small branch of the common femoral artery, in which the swelling did pulsate, and on account of which he deemed it necessary to tie the external iliac artery. It is the more important to bear in mind the possibility of formidable aneurisms thus springing from wounded smaller arteries, since the lacerations and complete divisions of trunk-vessels may not for many days be indicated by either hæmorrhage, aneurismal swelling, or the failure of life in the limb.

It sometimes happens that the first clear proof of the entire division of an arterial trunk is furnished to the Surgeon by the occurrence of gangrene in the lower parts of the limb. Arterial pulsation having ceased below the wound, the maintenance of life in the limb is dependent on the establishment of the collateral circulation. This fortunate occurrence somewhat rarely happens under such circumstances, and the probability of it is less in proportion to the severity of the whole injury, and to the swelling of the limb. The gangrene which attacks the extreme parts of a limb, in some instances creeps slowly on, and may stop; but that in which the higher parts die early, extends with great rapidity, and is speedily fatal.

Treatment of wounded Arteries.

The methods of treatment described in the chapter on HÆMORRHAGE are sufficient to arrest most cases of bleeding. When, however, the flow of blood is such as to require the application of a ligature upon an artery, various questions arise, the answers to which I have endeavoured to arrange in the following Rules. In this plan I have followed the example of Mr. Guthrie, and many of his "General Conclusions"† will of course be recognised amongst them. If I have in any particular deviated from the rules of practice, which his great experience in these injuries enabled him to sanction and recommend, I trust it will seem that I have not done so without some appearance of reason. Hæmorrhage should be prevented during the necessary manipulations by the employment of a tourniquet. If neither by this instrument nor by other ordinary modes of stopping the circulation, the bleeding can be stopped, it may be necessary to expose the trunk-vessel above the wound by a previous operation, and apply direct compression upon it.‡

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* J. Bell, *Surgery*, p. 448.

† Guthrie, *Wounds of Arteries*, 1846, p. 83.

‡ *Med.-Chir. Trans.* vol. xliii. Syme *on the Treatment of Aneurism.*

1. Wounded arteries, which do not readily cease bleeding, and which can be conveniently secured, should be tied. A Surgeon needs no more hesitate to adopt this rule in a case of accidental wound than he would after an amputation.

2. Moderate hæmorrhage from an artery which cannot be reached without enlarging the wound, should be stopped by a graduated compress. Indirect compression upon the arterial trunk above the wound may be added, if it is thought advisable. In the large majority of cases such hæmorrhage will not return.

3. Violent arterial hæmorrhage requires the wound to be enlarged, and the vessel tied. This rule is justified by the necessity of the moment, and by the possibility that a recurrence of such hæmorrhage, even if it should cease before the patient were exhausted, might prove fatal.

4. No operation should be performed with the object of securing a wounded artery unless it be actually bleeding. On the one hand, an operation has ceased to be necessary, and, on the other, the operator is very likely to fail in finding the wound of the vessel in the absence of the only sure guide to it, namely, the bleeding.

This rule may nevertheless be departed from when the torn extremity of a large artery is seen or felt to pulsate, and its permanent closure by natural means appears doubtful. An artery which has recently ceased to bleed may also be cut down upon and tied in certain emergencies. Such practice may be judged to be right when delirium tremens supervenes upon the injury, or when, as in some military movements, the wounded are ordered to be transported to another position. An instructive instance, in which this precautionary measure probably saved a man's life, is detailed in the *Surgical History of the British Army in Turkey and the Crimea*, before referred to, vol. ii. p. 345.

5. A wounded artery, when requiring a ligature, should be tied in the place where it bleeds. The reasons for this rule are as follows: *a.* When the trunk is tied higher up, the hæmorrhage may be renewed by branches which pass off between the ligature and the wound, so soon as the collateral circulation is established. A fibrinous plug may have formed in the hole of the artery, yet if, as the collateral circulation gains volume and force, the plug do not *pari passu* consolidate and cohere, there comes a time when the returning blood thrusts it away, and the hæmorrhage is renewed. It is impossible in any case to predict with certainty whether the circulation will first be reëstablished, or the wound will first be healed. A ligature on the subclavian will ordinarily stop the

bleeding from a wounded axillary artery. The ligature of the external iliac will ordinarily fail to do so when the femoral is wounded. Now, as the double ligature at the wound secures not only those patients who may recover when the trunk-vessel is tied at a distance above the wound, but also those who would die by that procedure, there seems no doubt that, if he can tie the vessel in the wound, the Surgeon should abstain from the higher and easier operation, and, cutting directly upon the vessel, should tie it above and below the wound. *b.* This course is urther advisable, since it is sometimes impossible, before finding the artery, to be certain that the trunk is wounded. It may be that only a branch of the main artery needs to be tied, but the higher operation necessarily obliterates the arterial trunk. *c.* In certain situations additional danger to life is incurred by the higher operation. Mr. Liston's fatal case* is an instance in which, a small branch only of the common femoral artery being wounded, the external iliac artery was tied, and the patient died the next day of peritonitis. He would indeed, in all probability, have died under any treatment, or with none; but it will be observed that his death arose from a cause entirely unconnected with the original wound. *d.* If after ligature of the trunk at a distance, it should become necessary to tie it again in the wound, the probable issue of the double obstruction to the circulation would be gangrene of the extremity; and amputation, as a third operation, would be most frequently fatal.

Nevertheless, since it is sometimes impracticable to tie the vessel in the wound, the trunk should then be secured at the next convenient place above the bleeding orifice. No other practice can be adopted in hæmorrhage into the mouth from the internal carotid artery, or in cases of external wounds which penetrate the floor of the mouth, dividing branches of the external carotid in their course. The ligature of the common carotid in such cases has proved successful. The internal iliac may require to be tied for wounds of its branches within the pelvis, and the radial, ulnar, or brachial, for some wounds of the palmar arch.

6. The external wound should be taken as the guide for the incisions. Muscles, and other intervening structures, the division of which does not endanger life, may be cut into or across in order to reach the bleeding point. When, however, the orifice of the wound is on the opposite side of the limb to the artery which is presumed to be the source of the hæmorrhage, a probe may be

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* *Med.-Chir. Trans.* vol. xxix. p. 157.

passed through the wound. The incisions made, where its point is felt, in the known vicinity of the large arteries, will lead to the bleeding vessel.

7. In exposing a wounded artery, the bleeding from which cannot be restrained by pressure on the trunk, the greatest precaution must be taken against the needless escape of blood. Cases are on record in which the hæmorrhage has proved instantly fatal. Whatever incisions it may be convenient to make through the skin and muscles, it is not at first advisable to enlarge the deeper part of the wound itself more than is necessary to admit the finger to the artery. The warm gush of blood guides the finger to the orifice in the vessel, and as soon as that is compressed, the soft parts may be divided at leisure to any requisite extent. John Bell's* description of the operation by which he secured a wounded gluteal artery, and that in which Mr. Syme† tied the common carotid, may be contrasted in this respect. In the former, the incisions and the hæmorrhage were vast; in the latter, an aperture was made large enough to admit the finger only, and the hole in the artery compressed by it before the incision even through the skin was further enlarged.

8. The artery, when found, should be tied both above and below the wound, whether it be completely or partially divided. The necessity for tying the lower end is the greater, because it is the more frequent source of secondary bleeding. When the lower end of the vessel cannot be found, a piece of compressed sponge, left in the wound, sometimes prevents subsequent hæmorrhage. This plan has been known to succeed when the wounded artery was the popliteal, and to fail when applied to the lower end of the radial artery, between the first and second metacarpal bones. For wounds of arteries near their bifurcation three ligatures are indispensable, as either branch may furnish the recurrent hæmorrhage. Mr. Guthrie, in the case already quoted, did not apply this rule to the common carotid when wounded at its upper end, being satisfied with the application of ligatures on the trunk and its external branch. It would doubtless, however, be safer to tie both the branches as well as the trunk. The same observation applies to the brachial and popliteal arteries, and generally to all cases in which bleeding continues after the application of two ligatures.

9. It is not generally advisable to apply a ligature immediately below the origin of a large branch. Secondary hæmorrhage does

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* *Principles of Surgery*, 1826, vol. i. p. 375.

† *Edinburgh Medical Journal*, vol. iii. p. 105.

not, indeed, necessarily take place, but the fact of its occasionally happening under such circumstances shows that the repair of the vessel is uncertain. The propriety of avoiding the neighbourhood of large collateral branches, when choice is possible, is confirmed by the rare occurrence of secondary hæmorrhage after the ligature of the common carotid and external iliac arteries, which give off no collateral branches.

10. Recurrent hæmorrhage, as well as that which happens upon the separation of a ligature from an artery, is to be treated according to its severity and the colour of the blood. When the blood is bright in colour and flows with alternating impulse, it issues from the upper end of the artery. As a general rule, the bleeding being great, it would be safest to tie the artery in healthy tissues between the orifice and the origin of the next collateral branch above it. If that cannot be effected, amputation, if practicable, should be performed above the bleeding point. If that be not practicable, pressure and astringents must be employed, and aided by indirect compression or ligature of the trunk higher up, according to circumstances. It must be confessed, however, that astringents can be of little avail in wounds of large arteries in the human subject.* Blood from the lower end of an artery approaches the colour of venous blood, and flows without cardiac pulsation. Such bleeding can usually be arrested by astringents and pressure, especially if care be taken to apply them directly upon the orifice of the vessel.

11. There are circumstances in which eminent practical Surgeons have deemed it less perilous to remove a limb than to search for a wounded artery in it. The propriety of this measure is sometimes founded on the exhaustion of the patient by previous hæmorrhage, sometimes on the state of the limb. Mr. Lawrence amputated a leg one month after a wound of the calf, on account of the continuance of hæmorrhage from the posterior tibial artery; "the swollen state of the limb and the reduced condition of the patient" forbidding the attempt to secure the vessel in the wound.† In a case of compound fracture, complicated with a wound of the posterior tibial artery, the lower end of the vessel went on bleeding for four months, and the limb was then amputated.‡ Mr. Syme has published a case of hæmorrhage from the axillary artery, not cured by the ligature of the subclavian, in which he amputated the arm

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* *Med.-Chir. Trans.* vol. xvii. p. 121. Cæsar Hawkins *on Styptics in Hæmorrhage from Arteries.*

† *Med.-Chir. Trans.* vol. xxix. p. 52.

‡ Allison *on Amputations*, p. 233.

at the shoulder-joint. The patient recovered; but it is open to question whether he would have done so, if, instead of removing the limb, Mr. Syme had cut off the supply of blood to it by tying the axillary artery, after having already tied the subclavian. Again, to be in an urgent case deprived of competent assistance must sometimes determine a prudent Surgeon to amputate rather than to attempt to secure the vessel. See the account of the difficulties attending the operation of tying the posterior tibial artery in Mr. Arnott's case.*

12. When it is ascertained that the principal artery of a limb is obstructed, whether by contraction, partial laceration, or complete division, as well as when a ligature has been applied upon it, no tight plaster or bandage should encircle the limb, no cold should be applied to it; but all care must be taken to preserve its life. A flannel bandage may be rolled around it; or, until an increase of its temperature shows that the collateral circulation is being established, it may be lightly chafed for a long period together by the hands of nurses.

13. If, nevertheless, gangrene should come on, the treatment will depend upon the rate of its progress and the state of the patient's system. No delay should be permitted when the mortification spreads rapidly, with swelling of the limb and increasing depression of strength. It may be permitted to wait for the formation of the line of demarcation, when the gangrene commences at the digits, and ascends slowly for days or for weeks.

A limb affected with a rapidly-spreading gangrene should be amputated above the affected parts, and, as a rule, at the level of the obliteration of the artery. When, however, according to Mr. Guthrie, the femoral artery and vein have been divided by a mere cut as high as Poupart's ligament, and mortification of the foot supervenes, the limb may be removed a little below the knee.

14. A wounded aneurism, when itself the result of an injury of an artery, is to be treated as a wounded artery. The wound of a spontaneous aneurism, in which the artery must be presumed to be diseased, is best treated by the amputation of the limb.

The subjects of traumatic aneurisms, arterio-venous tumours, and the operations for securing the several arteries, are treated in the essay on ANEURISM.

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* *Med.-Chir. Trans.* xxix.

WOUNDS OF VEINS.

No instance of healing can be more perfect than that of an incised wound of a vein. If made longitudinally in the course of the vessel, and carefully closed and compressed, as is done in ordinary venesection, no trace of the incision is discoverable a few days after the operation, even on the smooth interior membrane of the vein. Irregular lacerations heal with great readiness and with little scar. No impetuous outburst of blood separates the edges of the wound, as in arteries; for the weaker venous current is very readily controllable by well-adjusted pressure, even in very large veins. It consequently happens much more frequently in veins than in arteries, that a wound is repaired without the obliteration of the canal of the vessel. Surgeons have taken advantage of this circumstance in lateral wounds of large veins, as the femoral and internal jugular: instead of encircling the whole vessel in a ligature, they have raised and tied only the edges of the wound itself. The canal of the vein has thus been left open, and only narrowed according to the extent of the calibre of the vessel which has been included in the ligature (see p. 680). Such wounds heal perfectly.

Veins possess the power of contraction, and when divided in stumps, after amputation, they may be seen after a time to have diminished a little in calibre. But this power is very feeble and slow in exercise, and renders these vessels quite incapable of arresting hæmorrhage, either in the onward or retrograde direction of the venous current. Pressure, however, will readily control the bleeding of even large veins, and the freedom of their collateral communications lessens the force of the stream which issues from them. Pressure is also usually sufficient to arrest the bleeding from the largest veins divided in amputations; though occasionally, when the loss of blood may seriously affect the issue of the case, it is wisest to tie them.

Lacerations of veins by external violence are of separate importance only when the larger vessels are injured, as in a case described in the section on Wounds of Arteries. The inferior cava was lacerated to the extent of an inch, and the patient lived three hours. The duration of life after injuries of veins may sometimes, therefore, be considerable. In another instance, a man lived several hours with a wound of the lung, a rupture of the subclavian vein, and a fractured clavicle.

Some examples of spontaneous rupture of veins are on record. When greatly distended, they burst. Veins of the internal organs have sometimes been thus ruptured during the cold stage of an ague.

For wounds and ligature of veins as an assumed cause of purulent infection of the blood, see the articles on PYÆMIA and on DISEASES OF THE VEINS.

On the Entrance of Air into wounded Vessels.

A most startling occurrence has occasionally happened during certain surgical operations. Whilst every thing has been proceeding with perfect regularity and success, the sudden onset of most alarming symptoms, or instantaneous death, has unexpectedly arrested the operation. The accident is happily a rare one, but it has been observed sufficiently often to allow of our arriving at some conclusions with regard to it. In all the cases the operation which has been interrupted by this disastrous occurrence has been in the neck or the axilla; in all a sound of hissing, whistling, or gurgling has been heard by the bystanders, and this has been followed in not a few instances by death. In the words of Sir Charles Bell,* "Neither violence, nor loss of blood, nor even the bursting of the aorta, nor nervous influence, produce effects so sudden and appalling as this cessation of motion as by a lightning-stroke." In those cases in which the peculiar noise was not followed by instant death, symptoms of a dangerous character immediately supervened, for which nothing in the previous state of the patient could have prepared an observer. It is probable that both results spring from the one accident of air entering the heart, and that the difference in the two cases arises from the quantity of air admitted, a large quantity extinguishing life at once, a smaller quantity originating the violent but not fatal symptoms. I myself, at an operation on a tumour in the axilla, heard a sound corresponding to that described as accompanying the entrance of air into a vein; but it was almost immediately stopped by a movement of the tumour, and was followed by no symptoms at all. The patient lay tranquilly under the influence of chloroform.

It will be well to quote first some of the cases in which the fact of death or violent symptoms following the entrance of air into the veins has been ascertained; next to determine how the air enters; then to inquire how its presence in the system exerts the prejudicial effect attributable to it; lastly, the means of preventing and, if possible, relieving them.

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* *Practical Essays,* 1841, p. 11.

1. It has long been known to veterinary practitioners that the presence of a considerable mass of air in the veins of animals proves fatal, and the practice of killing horses by means of the injection of air is still sometimes adopted. The fatal quantity is well known, being about thrice that which can be blown at one expiration from the lungs of a healthy man.

On the 22d November 1822, Dupuytren excised, without difficulty or hæmorrhage, a tumour from the posterior and lateral part of the neck of a healthy young woman. As an assistant was raising the tumour, and the operator was separating its last attachments, a prolonged noise (*soufflement prolongé*) was heard in the wound, like that of air rushing into an exhausted receiver. "If it were not that I am far from the air-tubes," said Dupuytren, "I should have supposed we had opened them." The words were hardly spoken when the girl exclaimed, "*Je suis morte ;*" she trembled, and fell dead.

"The right auricle was distended like a bladder with air, which rushed out, unmixed with blood, when the auricle was opened. Blood and great quantities of air were found in all the vessels, and fluid blood in the other cavities of the heart. There was no unnatural appearance in any other part of the body."

In the sixteenth volume of the *Medico-Chirurgical Transactions*, Mr. Barlow, of Blackburn, recorded an instance of yet more sudden death. "On proceeding to dissect the skin aside to get at the basis of the tumour (one of large size in the side of the neck), a sudden and unexpected hissing, gurgling noise rushed obviously from a large divided empty vein, and the patient expired instantly without either sigh, groan, or struggle. Scarcely an ounce of blood had been lost." The author adds: "The vein appeared flabby and empty. The instant the atmospheric air gained access and filled the vacuum, the hissing noise ceased, the patient expired, and the mouth of the vessel collapsed." (p. 29.)

Under the title, *Alarming Syncope from the admission of Air into a Vein during an Amputation at the Shoulder-joint*, Mr. Bransby B. Cooper described a case which did not prove fatal. After the limb had been removed and the vessels secured, "I proceeded," Mr. Cooper writes, "to remove a gland from the axilla, and while dissecting it from its cellular attachments, I distinctly heard a peculiar gurgling noise, like air escaping with fluid from a narrow-necked bottle, and at the same instant the patient fell into a state of collapse, threatening immediate dissolution; the countenance was deadly pale, the pupils fixed, and inobedient to light; the pulse quite small and fluttering, although at intervals regular; the respiration hurried and feeble, and, at irregular intervals, attended with a deep sigh." Various restoratives were employed, but it was an hour before she could be removed. Upon being placed in bed, she passed fæces and urine involuntarily. She uttered a continual whining cry, and maintained a constant motion of alternate flexion and extension of the right leg, while the left remained perfectly quiescent. Symptoms of great prostration continued for several days, but she eventually recovered from the operation. She still dragged the left leg in walking when discharged from the hospital, six weeks after the operation.*

Dr. Mott, again, professor of Surgery in the University of New York, having divided the facial vein where it passes over the base of the lower jaw, in an early stage of an operation for the removal of a tumour, heard the gurgling noise of air passing into some small opening. "The breathing of the patient immediately became difficult and laborious, the heart beat violently and irregularly, his features were distorted, and convulsions of the whole body soon followed to so great an extent as to make it impossible to keep him on the table. He lay on the floor in this condition for near half an hour, as all supposed *in articulo mortis.* As the convulsions left him, his mouth was permanently distorted, and complete hemiplegia was found to have ensued; an hour or more elapsed before he could articulate, and it was nearly a whole day before he recovered the use of his arm and leg."

With these cases, the following very remarkable one may be classed, as the death in it appears to have originated from a similar cause, although not in similar circumstances. A private soldier, æt. 20, a somewhat delicate-looking lad, was wounded near the left knee-joint on the 18th June 1855. On the 21st September amputation was performed immediately above the knee by short lateral flaps, and the vessels were cut by a circular sweep of the knife after the completion of the flaps. The wound was at once closed with four points of suture, and covered with wet lint, which was secured by a couple of turns of bandage. The dressings were removed on the 23d. At one spot, towards the inner portion of the stump, and near to one of the sutures, a small portion of the integument looked likely to slough. The two sutures on that side of the stump were therefore removed, and a strip or two of common adhesive plaster applied. The lad had improved since the operation. On the following day, the 24th, the stump looked better, but healthy suppuration had not been set up, and the discharge was thin, watery, copious, and slightly fœtid. He was quite comfortable and in good spirits. The stump was dressed with water-dressing and oiled silk. "To our great surprise he died *suddenly* in the night." He had been talking and comfortable at eleven at night, and at one in the morning he was found by the orderly quite dead and nearly cold. A wounded sergeant in the next bed was unconscious of his death, so quietly had it taken place.

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* *Med.-Chir. Trans.* vol. xxvii. p. 41.

"On examination, twelve hours after death, the lungs were found healthy, but somewhat anæmic in appearance. The right auricle was full to distension of bright red froth (air mixed with blood), as was also the right ventricle, but the comparative quantity of air was less in the latter than in the former; the heart was otherwise quite healthy. The ascending cava was full of the same kind of frothy blood, of a bright scarlet colour, and distended by it, so that it felt like a portion of small intestine before it was cut into. This appearance extended as low as the junction of the two common iliac veins, but not lower. The surface of the stump had a grayish, sloughy, unhealthy look; there was no attempt at union except at one or two points of the integuments, and the surfaces were separated to some extent by gaseous products, having a fœtid odour, the smell of which was, however, that of decomposition rather than the peculiar odour of gangrene, and they were smeared with a dirty-looking sanio-pus. The periosteum was stripped from the femur as high as the intertrochanteric line, except at the linea aspera, and both bone and membrane smeared with the same secretion. There was no attempt at closure of the femoral vein, which lay quite open on the face of the stump, but its extremity was not sloughing."*

2. Upon the expansion of the chest in inspiration, an instant rush of atmospheric air takes place in all directions towards the thoracic cavity. The walls and floor of the chest support the weight of the atmosphere which bears upon them, and are not pressed in, but all the parts above the clavicles and sternum yield to it more or less. So far as the muscles and their fasciæ allow, the soft parts at the root of the neck are forced in towards the chest; but the vacant space is chiefly filled by air, venous blood, and the contents of the cervical portion of the thoracic duct. Air promptly enters by the open trachea, and distends the lungs. If the pleura were opened, it would rush in there, and has been known to do so with a whistling

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* *Medical and Surgical Hist. of the British Army in Turkey and the Crimea*, vol. ii. p. 277.

noise in the operation of ligature of the subclavian artery. The veins of the neck, which during expiration have gradually enlarged from below upwards, become empty and invisible with amazing celerity at the instant when the lifting of the chest leaves them unsupported under the weight of the atmosphere. Though not visible, the cervical curvature of the thoracic duct is probably subject to the same weight. Filled by the act of expiration, which forces on the lymph from the chest, it is emptied during inspiration by direct compression under the weight of the atmosphere, its valves securing that the current of lymph shall not be retrograde. The same weight has been known to act upon parts more distant from the thorax than the neck. My colleague, Mr. De Morgan, informs me of the circumstance, that a greatly dilated saphena vein in the groin of a patient of his became emptied after a few vigorous acts of inspiration. This could happen from no other force than the pressure of the atmosphere upon it. If now a vein in the neck or axilla, or a large cervical absorbent vessel, be held open during inspiration, the air must rush along it into the chest in precisely the same manner and for the same reason that at the same moment it is rushing down the trachea. It, however, passes into the right side of the heart instead of into the lungs.

3. The mode in which death results from the presence of air in the heart is still a subject of speculation. It is clear that a small quantity is not enough to prove fatal, or this manner of dying should be commonly observed when the air is being absorbed in cases of extensive general emphysema. Sir Charles Bell was of opinion that the instantaneous death arose from the access of air to the medulla oblongata. There is, however, no evidence that the air in the suddenly fatal cases has passed beyond the right side of the heart. The evidence is that the air in the heart destroys the life. In the absence of proof that atmospheric air is in itself noxious either to the structure or nervous susceptibilities of the heart, it remains to seek, in a right interpretation of the post-mortem phenomena, the cause of the fatal result.

The appearances observed in the examination of the bodies of persons who have died after the accidental entrance of air into the heart, present a general similarity in different cases, and an instructive variety. The largest quantity of air is always found in the right side of the heart. The most sudden deaths occur when the most air and the least blood are discovered in the right auricle and ventricle, and when the two fluids are least intermixed. In the same instances the lungs are found pale, and the left side of the heart contains but little blood, while the systemic veins are gorged with it. The appearances somewhat differ from this when life has been prolonged after the moment of the accident; the blood and air are then found whipped up together into a froth; and this froth is found, not only in the right heart and systemic veins, but also in the pulmonary arteries and their branches: there may even be air in the left side of the heart and the systemic arteries. The proportion of blood found in the systemic veins being still in excess over that in the lungs and arteries, the fact of the circulation being arrested in the right chambers of the heart is again established.

How does this arrest take place? Upon a right perception of this depends that of the whole mechanism of the accident, as well as of nearly all the treatment which is required in it. When air enters the right ventricle, that muscular cavity contracts, but a part only of its contents passes into the pulmonary artery; the remainder regurgitates into the auricle. For the tricuspid valve is not raised from the wall of the ventricle by so thin a fluid as air, and consequently does not close the auriculo-ventricular opening. In subsequent dilatations of the ventricle, additional air enters it from the auricle, and is either forced during the systole, or raised by its own light specific gravity, into the pulmonary artery. That which first occurred with the tricuspid valves now happens to the pulmonary—they cling to the wall of the artery and are useless. The ventricle, thus deprived of all assistance from the valves, communicates, both in its systole and diastole, with both its orifices, and draws in from, and restores to, both artery and auricle, the contents of both. The blood and air advancing and regurgitating thus at both the orifices of the ventricle, the circulation is nearly at a stand. Mr. Erichsen, in his essay on this subject,* after accurately describing much of this state of things, goes on to attribute the stoppage of the circulation to the obstruction which a frothy fluid encounters in traversing the capillaries of the lungs, and to ascribe to the lessened power of the ventricle only a subordinate place in producing the fatal result. That such a fluid encounters an obstruction he proves; but not that the obstruction causes death: and he leaves unexplained those cases in which death takes place before the blood and air are mingled into the "spumous froth," and in which, therefore, the obstruction in the lungs never occurs. By diverting his attention from the heart to the lungs, he missed, as I conceive, the primary cause of the arrest of the circulation, and the main point in the treatment, viz.

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* *Edinburgh Medical and Surgical Journal*, No. 158, p. 14.

the restoration of the action of the valves. The experiments and researches of Dr. Cormack on this subject led him to ascribe the obstruction of the circulation and the death to the great distension of the right side of the heart with air, not to the inaction of the valves.

4. All care must be taken by the Surgeon in the way of prevention of this distressing accident. He must be observant of the danger, and close instantly the mouth of any vessel which may be opened in localities known to be liable to it. He may appoint an assistant to compress the vessels between the site of his operation and the thorax, or to compress and close the veins both on the proximal and distal side of the wound. They will thus be kept both empty and motionless. He should avoid forcibly lifting a tumour from its bed, or suddenly raising the shoulder, a movement which might open the wound of a vein in certain situations, and permit the ingress of air into it. He may also bandage the chest, to avoid the danger arising from too deep inspirations.

Should air have entered a vein in sufficient quantity to embarrass the heart, the treatment must depend upon the symptoms. In those cases which do not speedily present the appearance of imminent death, it may be assumed that only a small quantity of air has reached the heart; that organ must therefore be aided in *gradually* forcing the air along the pulmonary artery. Such a case should be treated (1) by placing the patient in the supine posture, with the head low and the feet high; (2) by chafing the limbs in a direction towards the heart; and (3) by the administration of stimulants. (1.) The advantage of the recumbent posture may be looked for in the brain, which approaches, or is actually in, a state of syncope; from the posture being supine it will result that a part of the air in the auricle will be detained in the auricular appendix, and that all the blood which reaches the ventricle will be in the best position to raise the tricuspid valve, both being in the posterior and dependent part of the right chamber of the heart. The same difference in the specific gravities of air and blood must, indeed, equally raise air to the pulmonary valves as into the auricular appendix, and the inaction of those valves must probably be at least as fatal as that of the tricuspid. But our endeavour must necessarily be to restore that valve first to action which is first in the course of the circulation; and it is scarcely questionable that, if blood enough could be forced into the ventricle to secure one efficient action of the tricuspid valve, the immediate consequence would be a thorough contraction of the ventricle, the propulsion of that same blood into the pulmonary artery, and thereby a restoration of the action of the pulmonary valves. Let the tricuspid valves once act efficiently, and the circulation is restored; the remaining air will be carried along with it.

(2.) The recommendation of Mercier, to compress the femoral and axillary arteries, would be advisable, if the compression did not at the same time obstruct the corresponding veins. It would undoubtedly be to the advantage of the brain to receive all the blood which without that compression would descend to the limbs. But it must be observed that the great point to which our treatment should be directed is that of forcibly propelling into the right side of the heart blood which is kept by the air from entering it by the ordinary powers of the circulation. The right heart contains air, and is acting uselessly for want of blood: the systemic veins are full of blood. What is needed, then, is that the veins should be emptied towards the heart by repeated chafing of the limbs in that direction, and by pressure towards and at the root of the neck. Far from using compression, which might weaken or obstruct the circulation in the veins, we should by elevating and rubbing the limbs do all in our power to favour that circulation.

(3.) The administration of stimulants is called for both by the heart and the brain. Strong ammonia should be held near the nostrils, and brandy should be introduced either into the stomach or rectum. If the heart should lose instead of gaining power, shocks from the galvanic battery (which is now usually at hand during the inhalation of chloroform) should be passed across the chest.

The circumstances are different when the quantity of air in the heart is so great as to occasion imminent danger to life, or sudden syncope. The circulation is then almost or completely stopped, and the patients in the latter condition are described as quite dead. As, however, instances, like those of apparent death from drowning, do occur, in which resuscitation to life is possible although all signs of animation have disappeared, it will be right to make attempts to restore the patient even in the desperate circumstances under consideration. The principle of the treatment is the same as that already described, but the mode of carrying it out is different. No chafing or elevation of the limbs will force the venous blood into the right side of the heart in circumstances like these; for the quantity of air in the heart is much greater than in the former kind of case. Yet the difficulty is in great part the same, viz. the inaction of the valves. There is the same need of a denser fluid than air, but no external force can impel the blood into the ventricle. There is also distension of the right chamber to be met, which prevents the perfect contraction of the ventricle. It is necessary to relieve the heart of some of the air which burdens it, as well as to restore to it a fluid in which its valves can act. These two indications cannot be fulfilled by any plans which have been suggested: the air cannot be sucked out by a pipe passed into the heart through a vein in the neck, nor can any means hitherto adopted cause blood to reënter the right ventricle. Under these circumstances, the only remaining plan appears to me to be the injection of warm water into the heart. By means of this, if guarded by suitable precautions and aided by other means, the air would in part be replaced by the water, and the circulation might possibly be restored. The nozzle of the syringe is to be inserted into a vein of the neck, and water injected towards the heart. The precautions and the additional means are: 1. To raise the neck above the level of the heart; that, as the water is forced down, the air in the heart may be raised by it. 2. To open a vein in the neck, and evacuate the blood in it; that, as the air ascends during the injection, it may find space in the higher veins. 3. To throw in no additional air by a careless filling of the syringe. 4. To inject with force enough to ensure that the water reaches the heart, which the venous blood, being without a *vis a tergo*, cannot do, and yet with force so moderated as not to distend the right cavities. 5. To inject at a time about two ounces of fluid, and with sufficient velocity to ensure its not slowly trickling into the heart, which would be useless, but accumulating there in a quantity suited to raise the valves. 6. If air is perceived to ascend into a vein in the neck, it might be cautiously evacuated. 7. During the whole process the action of the heart must be solicited and maintained by powerful galvanic shocks across the chest, all means being, of course, in vain if the heart do not beat.

CHARLES HEWITT MOORE.

COLLAPSE;

AND THE GENERAL EFFECTS OF SHOCK UPON THE SYSTEM.

LIFE may be destroyed by certain agents which leave no visible traces of their operation in any part of the body. Some forms of injury, as, for instance, a blow upon the epigastrium, may produce sudden death, and yet the most searching scrutiny shall fail to detect the slightest physical or chemical change in any organ or structure. Nay, further; life may be abruptly terminated by causes yet more subtle, such as sudden and powerful emotions of the mind.

This kind of death is very expressively termed Death from Shock. The heart is powerfully affected through the nervous system, and its action is arrested.

This conclusion is founded upon the following evidence:

The absence of any discoverable lesion after death which can be connected with the violence which has proved fatal. Of course, it does not follow from the simple fact that, because this kind of death is deficient in what would be called its morbid anatomy, that therefore no change incompatible with life has been produced; but if we add to this the fact that some of these extreme cases recover rapidly without any subsequent evidence of lesion, we may reasonably assume its absence.

Although—granting the result of such experiments to be not always uniform—there is ample evidence to show that the heart in its action is not directly dependent on the general nervous system, that is to say, it will continue to act after the removal of the whole of the great nerve-centres, provided the operation be gently and gradually performed; yet it is equally clear and certain that the heart in its action is most powerfully influenced through the nervous system. This, indeed, is familiar knowledge to every one whose heart has ever "leapt from joy" or "sunk from fear." And this influence, if sufficiently intense, may stop its action altogether. This is what occurs in death from shock.

Death from shock, then, is the result of a sudden and violent impression on some portion of the nervous system acting at once through a nerve-centre upon the heart and destroying its action.

This conclusion is confirmed by the condition of the heart after death.

After death the heart is found full of blood. All its cavities are distended; although this is most obvious in the auricles and the right ventricle, the left ventricle not so readily yielding. The great veins, and the venous system generally, are also gorged.

The blood, as a general rule, coagulates very imperfectly. A considerable portion of it remains fluid, and the clots are loose and dark. In none of my experiments or observations have I found it altogether fluid, although there is no reason to doubt the statement of Hunter and others, that this is sometimes the case. Rigor mortis also commonly occurs; and it is, sometimes at least, very strongly marked. When slight and transient, it may easily escape notice.

Although the effect of shock is most obvious and immediately important upon the heart, yet there can be no question that its influence is general throughout the system, operating more or less upon all the organs. This relation which is established between any organ or structure and other parts through the nerve-centres has been aptly termed sympathy.

Nothing short of demonstrative evidence—actual experiment—could have established the fact that the whole of the great nerve-centres may be gradually removed without directly destroying the action of the heart, and yet that its movements may be at once arrested by a sudden and severe impression acting through them. This significant fact is especially important in relation to the present inquiry.

But these or other causes may produce an effect, short, indeed, of immediate death, but which nevertheless leaves a person on the verge of dissolution; and this condition is called Collapse. Its features in the extreme form are plainly marked.

The patient lies in a state of utter prostration. There is a striking pallor of the whole surface; most marked, from its contrast to the natural colour, in the face. The lips even are quite pale and bloodless. There is a cold clammy moisture upon the skin, and often distinct drops of sweat upon the brow and forehead. The countenance has a dull aspect, and appears shrunken and contracted. There is a remarkable languor in the whole expression, and especially in the eye, which has lost its natural lustre and is partially concealed by the drooping of the upper lid. The nostrils are usually dilated. The temperature is considerably reduced; and, if the person be able, he will complain of feeling cold, and perhaps shudder. Muscular debility is extreme,—apparent at a glance in the condition of the lips and hands,—occasionally even to relaxation of the sphincters. The pulse is generally frequent, sometimes irregular, always very feeble, perhaps quite imperceptible. In this latter case, although the ear may detect the fluttering action of the heart, the pulse does not reach the wrist. The respiratory movements are short and feeble or panting and gasping, "wanting the relief of sighs," sometimes imperceptible, although in the majority of such cases some action of the diaphragm may be detected by careful observation. Vertigo and dimness of vision are present. As the rule, there is not complete insensibility, although there is much variation in this respect, depending no doubt upon the nature of the injury; but the person is drowsy and bewildered, yet perhaps rational when roused. Sometimes the intellect is singularly clear and the senses perfect; the hearing occasionally even painfully acute. In the less extreme cases there is often nausea and vomiting with hiccup. The last is very variable in its occurrence.

The signs of syncope are those of collapse. Travers says, "a fit of syncope, and the recovery from it, present an epitome of the phenomena of shock."* So far as they extend, the symptoms of an ordinary fainting-fit are analogous to those of collapse. "They differ in degree and duration more than in kind." It is true that in syncope there is more uniformly a suspension of the mental faculties as well as of the senses and voluntary powers, but this may perhaps be explained by the fact that causes which produce syncope act more uniformly upon the brain. It has already been remarked that in collapse there is considerable variation in this respect—a variation doubtless due to the nervous centre through which the shock operates. In syncope the crisis is more rapid. In collapse the effects are more extensive and profound.

It can scarcely be necessary to remark that the symptoms just enumerated vary much in degree even in cases of complete collapse; and from this we form our opinion of the immediate result. As a general rule, the less the manifestations of life, the worse the prognosis. When the respiratory movements have ceased and the pulse is imperceptible, we anxiously listen in the region of the heart, and if we hear nothing there, life may be extinct. But it does not follow that recovery is impossible even in this desperate condition. In the first place, there may be some action of the heart still continuing, although too slight to be audible outside, and with this amount of life there must be some hope. But setting this question aside for the moment, others arise. In the absence of any discoverable lesion which in itself must prove mortal, what is there in such a case to preclude the possibility of recovery? By what facts are we convinced that in such a case a person is really dead? On the contrary, there is good reason for doubting; and if a doubt exist, the duty of the Surgeon is clear.

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* *On Irritation*, 1827, pp. 127, 128.

In experiments upon the higher animals, when the action of the heart is arrested by a shock, as by sudden destruction of the nerve-centres, its movements will, in many cases, be subsequently resumed; and, if artificial respiration be kept up, they will continue for a considerable time. Further, when temporarily paralysed by a simple shock, uncomplicated with any lesion, as, for example, by a blow upon the epigastrium, or by a current of electricity, the heart will often, after a shorter or longer interval of repose, resume its action and permanently recover. There can be no doubt that instances of this kind have occurred in the human subject. It is needless in this place to enter into a consideration of the ingenious explanation which has been offered of this fact,—that it is due to a temporary exhaustion of power, which, after an interval of rest, is renewed. It is enough to have the fact established. Nay, far less than this would be sufficient to demand from us the adoption of any means, for any length of time, which might possibly succeed in restoring animation.

When a person recovers directly from a state of collapse, he passes through the stages of what is termed reaction. This process, in the most favourable cases, is gradual, often occupying many hours. It may be many days before the system has thoroughly rallied, and the several functions have resumed their wonted harmony. Amongst the earliest symptoms of healthy reaction are improvement in the power and rhythm of the pulse, and fuller inspirations; an occasional deep sigh is, I think, a very favourable sign; so also is the power of swallowing; and, confirmatory of these, an increase of the temperature. Vomiting is commonly one of the early symptoms. An important sign of still further improvement is an inclination to shift the position; to move from the supine posture—which is emphatically the posture of debility—to one side. Subsequently there is, for a time, some excess of action, but it may be gradual and very slight. The person is a little feverish. The skin becomes rather hot, the face flushed, the pulse is rather frequent, and perhaps bounding, the urine scanty and highly-coloured, there is thirst, headache, and some restlessness. But at length the skin becomes moist, the person falls asleep, and awakes convalescent.

Other things being equal, the longer the symptoms of reaction are delayed, the more unfavourable is the prognosis. If at the expiration of some hours no symptom of its commencement appear, the patient's condition is certainly desperate.

But a state of collapse may end neither in immediate death nor in direct recovery. The reaction may be imperfect, and that condition which Travers has described as "prostration with excitement" may supervene, and this may lead indirectly to a fatal or favourable issue.

This state is marked at first by dry heat of the skin, a flushed face and anxious expression, a rapid and bounding pulse, which is sometimes even sharp, but always easily compressed. The respiration is hurried and imperfect, with partial and irregular sighs. The tongue is tremulous; there is often urgent thirst; vomiting is a frequent, and sometimes most obstinate symptom; there are occasionally rigors. The languor or stupor of collapse is succeeded by restlessness, jactitation, tremor and twitchings of the muscles, præcordial anxiety; often, but not always, delirium of various degrees, from occasional incoherence to wild and fierce excitement: this most frequently occurs, and is more marked, during the night. There is either an entire absence of sleep, or it is partial and interrupted, and is succeeded by no relief. As the exhaustion increases, the skin becomes covered with a cold and clammy sweat, which is very often profuse. The face becomes pale and the expression haggard; the pulse innumerably rapid, irregular, fluttering; subsultus comes on; slight convulsions; coma more or less profound; and death.

The symptoms are subject to considerable variation, both with respect to the periods at which they supervene and their manifestation. Perhaps the disturbance of the cerebral functions is, of all, most variable. There may be little more than a peculiar irritability of manner, with an increased disposition to talk, sometimes rationally, occasionally incoherently. Often there are strange illusions, attended with a peculiar dread of impending evil: or, on the other hand, there may be the fiercest maniacal raving. Lastly, it may present all the features of—in fact, be—a case of ordinary delirium tremens.

Now these symptoms of extreme excitement, leading so rapidly to fatal exhaustion, are unquestionably evidence of excessive action and deficient power. Hunter calls it irritability. There is no more important subject for inquiry than the relation of action to power in the living body. In the condition of health the balance is uniformly maintained, or at least the supply is equal to the demand. But if from any cause the power of an organ, on the function of which life is immediately dependent, be much impaired, this difficulty arises: its function must still be discharged to an extent at least sufficient for the purposes of life, and therefore deficiency of power may need to be redeemed by increase of action. But action involves exhaustion, and repose is needed for repair. The greater the effort, therefore, the greater the exhaustion. But again, decreasing power must be met by increasing action. Thus cause and effect react each on the other; the relation between power and action becomes more and more reversed, until at length, the supply diminishing, and the demand for action and repose alike augmenting, the crisis, with rapidly increasing pace, is hurried on.

No organ illustrates this so strikingly as the heart, and under no circumstances better than in the present case. An impression is produced upon the heart whereby its power is for some time impaired. But, that life may last, it must still to a certain extent circulate the blood. If it be too feeble to accomplish this necessary task at its ordinary rate of action, its frequency must be increased. But action is succeeded by corresponding exhaustion; and so, if the supply prove unequal to the demand, follows prostration with excitement,—deficient power and excessive action; the pulse increasing in frequency as it fails in force.

In this way collapse may indirectly terminate in death through excessive and exhausting reaction; or, if happily the power be sufficient to restore the equilibrium, in ultimate recovery.

In reference to these cases it is interesting to note, that in others reaction may be for a long while—perhaps some days—very partial and defective; sufficient, indeed, to protract life, but rendering the prognosis extremely doubtful.

The principal causes of collapse are:

Injuries sudden and severe, or extensive, as contused and lacerated wounds, involving a considerable amount of texture—the crushing of a limb, for instance. Burns present familiar and striking examples of extreme collapse produced by this cause. Under this head, too, come capital operations.

Injuries of very important organs, as the liver, or other of the viscera; or of the joints; or other organs abundantly supplied with nerves. Sudden crushing of the testicle has proved fatal.

Pain alone, when intense and protracted, has proved fatal in this way; and it appears, in a case related by Sir A. Cooper in his first lecture, that sudden relief from great agony was attended with the same untoward result.

Certain poisons operate in this manner, depressing the system so suddenly and severely as to produce a state of collapse;—tobacco, for example. And drastic purgatives have in some cases induced a similar condition.

The purest examples of collapse are those which are produced simply by what is termed a shock to the nervous system. A severe blow upon the epigastrium, for instance, may produce immediate death without any detectable lesion. A current of electricity acts in the same way, as in death from lightning. Simple concussion of the brain is, perhaps, the example most commonly presented to our notice as surgeons. In this case, however, the ordinary effects of shock are complicated by the insensibility which naturally results from the nature of the injury.

There can be no doubt that in some cases a mental emotion alone may destroy life. And although this extreme effect is very rare, yet doubtless there is no source of shock to the system so frequent as the mind. Its subtle operation is most marked in its relation to what are termed the organic functions. Its influence upon the functions of the stomach and intestines, liver, kidney, skin, and other organs, is well known. A familiar instance of the extent of its influence is seen in women during lactation. The qualities of the milk are from this cause often suddenly changed, so as to produce very serious effects upon the infant. In some recorded cases the result has proved fatal.

It is remarkable and characteristic that severe shocks to the system from mental emotion, after the more immediate effects have passed away, often leave some organ permanently impaired in its function. Sudden fright, for instance, has produced deafness.

Some injuries tend to produce collapse in more than one way. The collapse following gun-shot wounds, for example, may be due, partly to the extent of the mischief and the organ or organs involved in it, assisted more or less by hæmorrhage according to its degree; and undoubtedly, in many instances, partly to the effect upon the mind of a sudden, and probably severe, injury, the nature and extent of which are doubtful.

Again, the shock produced by the cold douche is doubtless increased by the depressing effects of great and rapid reduction of temperature.

The effects of shock are aggravated by loss of blood. Hence a comparatively slight injury, if accompanied by considerable hæmorrhage, will produce a more profound impression on the system than one much more severe without this most important complication.

But hæmorrhage alone, if sudden and profuse, will produce collapse. Excessive hæmorrhage, even if gradual, will produce a state of extreme exhaustion and debility, and death from anæmia; but this is not the same as collapse from loss of blood, which depends rather upon the suddenness than upon the amount of hæmorrhage. In sudden and profuse hæmorrhage, the heart and system generally are not only directly affected, but indirectly through the great nerve-centres by the abrupt abstraction of blood.* And although after death from simple shock without any loss of blood the heart is found distended with blood, while after death from sudden hæmorrhage it is more or less contracted, yet the difference appears to be due principally to the quantity of blood in the system; for if in the former case the distended heart be relieved by opening a large vein, it will assume very much the condition met with in the latter case. Moreover, the symptoms produced in each case are to my observation similar; and although it is of the greatest importance to distinguish between the causes, yet in either case the condition induced is a state of collapse.

Perhaps the chief distinction between the symptoms of collapse the result of sudden and profuse hæmorrhage, and of that from other causes, consists in this: in the former the effects are for a time most obvious on the vascular system; the functions generally not appearing depressed to the same extreme degree. Thus, when the pulse at the wrist may be imperceptible and the heart's action hardly, if at all, audible, the voice will continue clear, firm, and loud, and the physical and mental powers considerable. Such a condition is often witnessed in hæmorrhage during labour. This contrast is, however, of course, only temporary; and the same is sometimes seen in collapse from other causes, as, for instance, in Hunter's own case.†

Hitherto the influence of shock has been considered only in its extreme effects when directly producing a state of collapse; but it must be a very narrow view of the subject which would overlook its less severe though much more frequent results. It may operate in any degree, and produce in one case, as has been already seen, instant death, or a state not to be distinguished from it for a time even by the most anxious scrutiny; in another case effects so trivial that the symptoms pass unnoticed or unheeded by a superficial or careless observer.

There are many instances on record, and many more known to every surgeon, of death from this cause less sudden, but in many instances scarcely less inevitable. In some cases injuries or operations, comparatively trivial in their nature, induce a condition of otherwise unaccountable debility, and terminate in death by asthenia. A careful inquiry into the history of such cases will often elicit facts which enable us to reconcile the apparent disproportion of cause and effect.

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* See Marshall Hall, *Med.-Chir. Trans.* vol. xvii.

† *Works*, by Palmer, vol. i. p. 244.

After injuries or operations sufficiently severe to produce a serious impression upon the system, yet by no means amounting to a condition of collapse, reaction is sometimes defective or unduly delayed. The patient remains depressed; there is no heat of surface; the pulse is weak and perhaps unsteady; he does not sleep soundly, although he may be constantly dozing; and the stomach is often irritable. In a word, there is an absence of "sympathetic fever."

There are some circumstances which greatly affect the result of shock in its various degrees upon the system.

General debility favours the influence of shock. A weak system is more easily impressed and disturbed, and reaction fails from want of power.

In the same way very much depends upon what is termed the state of the constitution, or rather the idiosyncrasy, of the individual. An injury which will produce no visible effect upon one man, scarcely inducing even a temporary disturbance of any function, will in another produce a most serious and enduring impression. Yet both of these subjects shall be previously in perfect health; but there is often, though not always, a visible difference in their temperament, by which our judgment is materially guided in calculating the probable effect of any operation or injury.

The effect of any shock is most disastrous in those whose constitutions have been previously broken down by debauchery or excess. These labour on, inadequate to the ordinary demands of every-day life, and utterly unequal to the extra claim which a comparatively small injury makes upon the vital powers. These are the cases that so often terminate in delirium tremens.

As life declines, the vital powers diminish, and this decrease becomes strikingly apparent when any injury or disease leads to an increased demand upon the resources of the system. There is less power in reserve, if it may be so expressed; less constitutional capital. In old age the system may be equal to the task of maintenance, but it is much less capable of the extra exertion of repair. Hence those advanced in life are slow to rally from the effects of shock. Reaction fails. Sudden confinement to bed alone often produces a very serious impression upon old people. The system in advanced life often appears unequal even to this change. Thus an injury in itself insignificant may in this way, by rendering confinement to bed necessary, lead to a fatal result. Surgeons are aware of this, and in the treatment of fracture of the neck of the femur, for example, are anxious to see the patient about again as soon as possible.

The capacity for reaction must not be confounded with the power of resistance. Indeed, generally they are inversely proportioned to each other. A certain degree of shock may produce a very obvious disturbance of the system in the young, which nevertheless soon subsides. In the old the same influence may be attended with scarcely any visible effect, yet when an impression is made it endures. So the influence of shock is more manifest but more transitory in the young; less obvious but more fatal in the old.

Apart from all considerations relating directly to the body, the character and condition of the mind exert a more subtle but most important and interesting influence upon the effects of shock, especially in its less extreme degrees. Perhaps it is not always known how much the result of an operation is regulated by this cause. It seems that in some instances a firm and deeply-rooted conviction that recovery is impossible may alone suffice to prevent it. There are instances on record of death after the most trivial operations, which can be explained in no other way. Nay more, as already noticed, death has been directly produced from mental emotion, without the intervention of any other cause. And even in such instances as those related by Travers and others, it cannot be regarded as a predisposing cause only. The trivial operation is but indirectly connected with the fatal result as the exciting cause of the mental condition. Although these extreme instances are comparatively rare, yet, on the other hand, it may be affirmed that in every case the result of a severe accident or operation is more or less influenced by the state of the mind. We speak familiarly and truly of certain emotions as depressing, and of others as exciting; and it is not difficult to understand that much must depend upon the question,—with which of these is the inevitable shock of an operation or accident to be associated?

Those who have watched patients the most closely attach the greatest weight to this matter. A nurse has often considerable advantage over the surgeon in this respect. She becomes more thoroughly acquainted with the condition of the patient's mind, and its influence upon the system. I have more than once talked over this subject with the intelligent sisters of the wards which are more especially devoted to cases of operation at St. Bartholomew's Hospital; and I think many would be surprised at the vast importance they attach to the condition of the mind in determining the result. Many times, when to a passing observer the state of a patient has appeared to be in every respect satisfactory, I have seen the sister shake her head, and heard her say, "He would do very well if he were not so nervous; but he will never get better while he continues to persuade himself that he cannot;" and rarely has the prediction been proved to be false.

There are at least two distinct forms of mental influence operating powerfully upon the result. The first is either the buoyancy produced by hope and a firm belief in a successful issue, or the depression produced by despondency and a rooted conviction that the result will be fatal. The second is either a calm and equable disposition, patient and enduring, or a peevish and irritable temper, restless and complaining. The former of these are usually influenced by age, and the latter by sex. The young are the most hopeful, and women as a rule endure most patiently.

In this way may be explained, without impugning the authenticity of the actual facts, many of the marvellous stories which some people like to relate; such as the prognostication of the result of an operation or injury which at the time seemed opposed to all reasonable calculations; the verification of dreams, &c.

Other conditions being the same, the immediate effect of any shock upon the system varies as the intensity of the impression. Hence the greater fatality of large amputations for accident when compared with those for long-standing disease. In the former case a sudden and severe injury is closely followed by a large operation, and the person passes at once from a state of activity to one of close confinement. Here are all the conditions calculated to produce a profound impression. In the latter case the person has become accustomed to confinement. His habits of life after the operation are not abruptly changed. There is no shock from an injury antecedent to the operation, and the system is less startled by the irritation of the wound when previously to some extent prepared for it by the accustomed irritation of the disease.

A similar explanation may be applied to the comparatively great danger of what are termed "operations of expediency." The shock to the system is greater when previously unaccustomed to any unusual demand upon its resources.

In the treatment of collapse in its extreme degree, our object is to maintain, and, if necessary, to excite, a sufficient amount of action for the purposes of life till the system is enabled to rally from the exhaustion produced by the shock. A certain amount of action is essential to life. The heart must beat and the patient must breathe. Here it becomes necessary to distinguish the two cases previously described,—collapse without hæmorrhage, and collapse the result of sudden and excessive hæmorrhage. With regard to the treatment and the issue of the case, this distinction is of primary importance.

First, then, of collapse the result of a severe shock without hæmorrhage. Supposing the most desperate case, in which no sign of life can be detected: is any thing to be done? So long as the slightest doubt remains, the case is not absolutely hopeless. In the absence of any positive evidence to the contrary, such as the lapse of time or the complication of irreparable injury, we assume that recovery is not impossible. When the respiratory movements have ceased, artificial respiration should be patiently practised; and if there be any evidence of the heart's action, it should be perseveringly continued until we obtain evidence that the function is naturally performed.

If no evidence of the heart's action be detected, can any thing be done to excite it?

If an animal be killed by shock, such as sudden destruction of the spinal cord and brain, and the chest be opened within a minute or two of the operation, the heart will be found motionless, or with the slightest flickering movement, most apparent in the auricles, and *distended* with blood. The veins too are in the same engorged condition. If now the right auricle or ventricle be punctured, blood will pour out, and this will be instantly followed by a striking increase in the heart's action, which will continue to improve for some time. Or if the distended jugular vein be opened in the neck, the heart will resume its action as soon as relieved. While the heart remains paralysed by distension, it cannot recover.

In such a case, therefore, the superficial veins of the neck should be examined; and if distended, the external jugular should be opened. This treatment is sanctioned by both reason and experiment. Nothing else seems to offer any prospect of success. Electricity has been recommended; but even if it could be obtained at the precious moment when required, the principle of its application is, to say the least, a very doubtful one.

While these means are practised, the temperature of the body must be carefully maintained. This important precaution is apt to be neglected during the prosecution of more active measures. As the circulation fails, the temperature falls; but the person must not be allowed to grow cold.

If there has been considerable hæmorrhage, our chances of success are greatly diminished; and when such extreme collapse as that just spoken of is the result of hæmorrhage, the case is desperate indeed. In such a case, transfusion is the sole means that offers a chance of life. The difficulty of its immediate adoption is generally fatal to its employment; but if practicable, it should certainly be attempted. It is unquestionably "a fair and rational expedient."

But if we should happily succeed in exciting the heart to resume its action, or in less desperate cases where it still acts, when the symptoms are such as were described at the commencement, how shall these actions be best maintained?

While, on the one hand, it is absolutely essential that these actions shall be to a certain extent continued at whatever cost, on the other hand it is of extreme importance that the flagging powers be not unnecessarily tasked. Time is a most important element in these cases; and if in the interval we can keep the patient alive, the system will sooner or later rally from the effects of shock, if uncomplicated with any mortal lesion. The chief point of difficulty is to decide how much to do; when to act, and when to desist. If by imprudent and impatient attempts to increase action, we draw too largely on the already exhausted powers, we hasten the catastrophe; but nevertheless we watch narrowly that the feeble functions do not decline. "We have two points especially to bear in mind," says Travers; "first, maintaining action; secondly, not forcing it." During this critical period such a case should not be left for an instant. The patient must be strictly kept in the horizontal position, with the head on a level with the trunk; and he should not be raised to any extent till reaction is fairly established. Amongst drugs there are many stimulants, but in these cases nothing is equal to brandy. Its effects are most certain and decided, and it suits the stomach best. It will remain when all other stimulants are rejected. The state of the circulation and the temperature are the guides to its use. However, there should be a limit even to the administration of brandy. If no effects are apparent after an ounce or two have been swallowed, it is very questionable if any advantage will be gained from a larger quantity. It frequently happens, that after several ounces of brandy have been given without benefit, they are suddenly returned. The stomach, no longer able to absorb its contents, is thus stimulated to expel them. The application of heat to the epigastrium and the extremities is most useful. Flannel-cloths wrung out of hot water and applied to the pit of the stomach are often of signal service. If the patient be unable to swallow, stimulating enemata should be administered. With all this, the temperature of the body generally should be maintained. As the natural production of heat fails, its loss must be prevented as much as possible and supplied by artificial means. Nourishment should follow stimulants very closely. Stimulants alone may be required in the first emergency, but they soon prove useless if unaccompanied by nourishment. The two may be combined with the greatest advantage; and as the system rallies, stimulants are gradually withdrawn.

Where there has been considerable loss of blood, the demand for nourishment is much more immediately urgent, and must be more abundantly supplied in the most assimilable forms. In this case reaction is longer delayed and more gradually developed.

I cannot resist transcribing the following remarks, by Travers, in his work on *Constitutional Irritation*, with reference to this great question.

" If we neglect to supply stimulus when called for, the spark of life goes out. The signs of its indication must therefore be vigilantly observed. We are maintaining action upon inadequate power, in the hope that the natural resources may come to our relief, and that we may gradually diminish stimulus and increase nutriment, which is our only method of raising power to a balance with action.

" The respondence of the circulating forces to an increased supply of stimulus must serve as a caution against over-supply. Since power is deficient, we must carefully husband our only resource, and not waste it in inordinate action. When the signs of reaction are manifested, its excess is much to be apprehended, if such reaction has been obtained by over-stimulation.

" Excessive reaction so induced is 'prostration with excitement' in its most perilous form. When such a state is the original form of the malady, it is probably less dangerous, because in this case the inequality between power and action is less."

If from injudicious treatment, or otherwise, reaction becomes excessive, we have the condition previously described—" prostration with excitement." In this case the indications of treatment are clear and simple enough, but unhappily most difficult to fulfil:—to support and increase power, and to moderate and reduce action. We would rather give nourishment than stimulants, but unfortunately the latter are generally necessary and cannot be spared.

When the stomach is irritable and rejects its contents—a common and untoward complication—small pieces of ice, swallowed from time to time, are usually most grateful to the patient and beneficial in their effect. Mustard-plasters to the epigastrium are also frequently useful; and if not, possess the great merit of being harmless.

Mental excitement may be often moderated by keeping the head cool. The beneficial effects of sleep are never more strikingly seen than in cases of this kind. A few hours of sleep will sometimes altogether change the condition of the patient. Unfortunately, in proportion as it seems needed, it becomes most difficult to procure it. In the worst cases, the absence of sleep is a striking feature. But full doses of opium will often accomplish this desirable end; and it is when opium thus acts that it proves most signally serviceable.

It is the most valuable of all drugs in this condition, and the system will generally tolerate and require unusually large doses. If the patient cannot or will not swallow, it may be given by the rectum. Dupuytren preferred this way to the other of administering it.* As a very general rule, it may be said that opium proves beneficial in proportion as the symptoms of syncope predominate. It is contraindicated when those of coma appear.

When opium fails or disagrees, henbane will often prove a very valuable remedy, or they may be given together. "There is a charm in its operation altogether peculiar." It "soothes and stills."

Concerning the treatment of deficient reaction after injuries or operations there is little to be said. The earliest evidence of failing power, either in the state of the pulse or the temperature of the surface, must be met by support in the form of assimilable food, and, if necessary, by stimulants. Hæmorrhage, according to its extent, will delay and impair reaction. Perhaps it sometimes happens that healthy reaction, which in the course of nature should succeed an operation or injury, is for a time averted or altogether destroyed by a depletory plan of after-treatment, adopted with an idea of preventing inflammation, or some one or more of the many ill-defined and as little understood evils associated with that term. While all goes on well, beyond giving a sufficient amount of support, in a light and simple form at first, the less that is done the better. Should reaction fail, stimulants must be added to the requisite extent, their effect upon the system being carefully watched. Of the indications for their use Mr. Vincent says, in his *Observations*, "If in twelve hours, or earlier, the pulse does not indicate increased action, if it becomes fluttering and unequal, when the surface does not seem to evolve heat; when the countenance is listless, and, perhaps, when the patient reports himself better than it might be expected; and particularly if he is not clear in his answers, but is wavering,—then that best of all stimuli, brandy, must be thrown in, and if there be delirium, opium." If the stomach prove irritable, as it often will in these cases, ice and mustard-plasters, as previously mentioned, will be, I think, serviceable. Sleep must be obtained; and morphia, with or without some stimulant, will generally procure it.

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* *Leçons Orales*, t. i. p. 187.

Both deficient and excessive reaction indicate want of power. They are equally evidence of debility. The circumstances of the case determine which shall for the time prevail. The one condition very commonly passes into the other.

Inasmuch as a shock to the system is, under all circumstances, an evil in proportion to its extent, it behoves us in every case, where it cannot be altogether avoided, to lessen its operation to the utmost. It is to be remembered that, concurrent with the shock of a severe operation, there are many added impressions, all tending to produce a similar effect. For instance, in many cases there is, besides a total alteration of diet, a sudden change from activity to close confinement. This is, as we have seen, sometimes of itself sufficient to induce extreme prostration. Under any circumstances it is a matter of great moment. Travers tells us that his friend Mr. George Young was accustomed, where he could, to get over this difficulty beforehand. He would "impose restraint before the performance of operations requiring confinement with excellent effect. Having to extract a cartilage from the knee-joint, he would keep the man for a week prior to the operation in the same position that was to be maintained for the week subsequent to it. Thus the irritation of confinement, as well as that of motion, was avoided." And in a case related: "This confinement of the limb occasioned a restless night, some fever, a whitish tongue, quickened pulse, a little headache, spare and high-coloured urine."

Certainly in all "operations of expediency," and in others too that will admit of it, this plan is well worthy of adoption. It costs so little, and may save so much.

Moreover, from the evidence before us, it is clear that, prior to an operation, the state of the mind as well as of the body should be carefully investigated; and if an unfavourable condition cannot be corrected, it should be allowed due weight in determining the question of an operation. And on this account, when an operation is decided on, it is unwise as well as cruel to delay or postpone its performance without some good and weighty reason, for doubt and anxiety draw largely upon the health and strength.

These and similar matters are never trivial and of little moment, for they are always more or less influential in determining the issue.

Supposing a person in a state of extreme collapse from a severe injury, the crushing of a limb for example, and a capital operation, such as amputation, to be necessary, the operation should be performed so soon as the patient's condition will admit of it. Although it would be highly hazardous to operate while the prostration is extreme, yet it is not necessary, or even advisable, to wait for complete reaction. How far the patient should be allowed to rally, and when he has reached that state which will enable him to bear the operation, are, of course, questions which cannot be answered in a general manner, but which must be decided by the Surgeon in each case. Yet it is to be borne in mind that the immediate impression which an operation makes on a system already under the influence of a shock is considerably less than under other circumstances. It is said: "The shock of the injury covers and identifies with itself that of the operation promptly performed." Of course, so far as the effect of the operation alone is concerned, it would be safer to wait until the system had entirely recovered, if it could do so, from the previous impression; but as valid reasons are opposed to this delay, and we are compelled to inflict an additional injury on a system already depressed, it is very important to be fully cognisant of the fact that the shock of an operation, in such a condition, will be reduced to a minimum.

It is sometimes stated that an operation performed under these circumstances does good by arousing the system. *Similia similibus curantur.* It is certainly true that it will sometimes produce a temporary display of action; but, be it remembered, always at the expense of that power which is already so exhausted. Of all means of exciting action this is certainly the least economical.

In such extreme cases the use of chloroform, as a rule, is not admissible, or at any rate not advisable. Although doubtless, under ordinary circumstances, it considerably mitigates the shock of an operation; yet in these cases, as just stated, the shock is already greatly reduced, and chloroform cannot be safely administered to a patient so depressed. More than once I have watched the feeble and irregular pulse altogether disappear as chloroform was inhaled, and revive again when it was discontinued. Moreover, the grand reason for its employment is wanting; for a person in a state of collapse, from the great exhaustion of the functions of the nervous system, is scarcely conscious of pain.

WILLIAM SCOVELL SAVORY.

BURNS AND SCALDS.

BURNS and scalds are, beyond all comparison, the most commonly fatal injuries which occur in civil life;* and the liability to this accident appears to have been largely increased of late years, by the extended use of steam machinery, the invention and universal employment of lucifer-matches, and the nature of the modern materials and fashion of female dress. They are also, of all accidents, those which involve the most agonising pain and the most protracted suffering; and they frequently condemn the unhappy patient to a lifelong mutilation of the most repulsive and distressing kind: they are surrounded in every period of their course by dangers, against which constant precaution must be taken: they require sedulous attention to procure the healing of vast ulcerated surfaces, to prevent deformity, to support the patient's strength, to obviate or cure visceral mischief: and they often offer most gratifying rewards to skill and patience, even in cases where ulceration has been pronounced incurable, or deformity condemned as irremediable. For all these reasons they deserve a more attentive consideration than they usually receive from either students or practitioners of surgery.

These injuries have been variously classified, into four divisions by Heister and Callisen,† into six by Dupuytren,‡ and various other divisions have been proposed; all of them indicating the depth of tissue implicated in the injury. Of these, Dupuytren's is the one which is most widely accepted, and which seems at once the most complete and the most practical. I shall therefore follow it in this essay, merely observing that, although of great utility, it does not, and is not intended to, embrace all the elements necessary for prognosis and treatment. It indicates the *depth* of the burn at its deepest part; but another, and perhaps even more important, consideration is the *extent* of the burnt surface—a matter which necessarily eludes formal classification.

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* Mr. Crompton quotes the following statement from the Registrar-General's report for 1845: "Whilst 3305 persons were killed in one year by every kind of mechanical injury, in the same period 3057 were lost by fire, viz. 148 by explosions, 2577 by burns, and 332 by scalds." *Trans. of the Provincial Med. and Surg. Ass.* vol. xviii. p. 19.

† See Frank, *Lehrbuch der Chirurgie*, 1849, vol. i. p. 340.

‡ *Leçons Orales*, &c., Paris, 1839, vol. iv. p. 508.

The six classes, then, into which the great French surgeon divided burns and scalds are these: *First*, Erythema, or superficial irritation (‘*phlogose*’) of the skin, without formation of phlyctenæ. *Second*, Cutaneous inflammation, with separation of the epidermis, and formation of vesicles filled with serosity. *Third*, Destruction of the papillæ and part of the thickness of the skin. *Fourth*, Disorganisation of the entire dermis down to the subcutaneous cellular tissue. *Fifth*, The conversion into eschars of all the superficial parts, and of the muscles down to a distance more or less considerable from the bone. *Sixth*, The carbonisation of the whole thickness of the burnt part. Of course, burns, which according to this classification are described as of a particular degree, will often, and indeed usually, involve all the lower degrees as we proceed further from the spot at which the burn has been most intense.

The first degree is characterised by mere superficial redness, fading without any definite edge into the natural skin, and by a tingling sensation, and often intense tenderness to the touch. The injuries of this kind which surgeons have to treat (for the slighter cases are seldom brought under medical care) are often very extensive; being produced by the sudden and transient application of flame over a great part of the body, as in explosions of gas. They are then very grave accidents from the depressing influence which is exerted upon the brain and heart, although in all such cases the local injury is not formidable, since no sloughing is to be apprehended. The epidermis will remain to protect the surface of the true skin till a fresh layer is produced, when it separates, and the case is at an end.

In the second degree, the local injury has been carried a little farther, and the sudden afflux of blood to the surface of the cutis has been relieved by the transudation of the serum from its vessels, forming bullæ. Here the skin is in more danger than in the former case, since the detached epidermis is very liable to be peeled off, especially in extensive scalds, where the detachment is often very considerable, and where it is not rare to see a glove of epidermis separate from the hand or foot of a patient, just as it does from a macerated subject.

In the third and fourth degrees of burn, the true skin is involved, partially in the former, and in its whole thickness in the latter. It is a matter of importance to distinguish these two varieties from each other, in reference to the question of the probability of resulting deformity; but it must be confessed that it is not always possible at first. The surface in both is burnt dead, and is hard, tough, parchment-like, mottled with the débris of the blood which was contained in the tissues, and varying in colour in different cases: this variation depending either upon differences in the agent by which the accident has been produced, or upon other causes difficult of determination. Beneath this eschar lies, in the former case, the deeper part of the cutis, not disorganised, but in the commencing stage of the inflammation which is a necessary consequence in the separation of the slough; in the latter, merely the loose subcutaneous cellular tissue, which is itself in most cases somewhat frizzled by the heat. Hence it generally contracts to some extent, so that the skin around the eschar is more puckered in the severer than in the less serious injury; and the eschar also in the former has a denser and more parchment-like appearance than in the latter. It is difficult to give an idea of this by description; but those who are familiar with these injuries soon acquire a tolerable idea of the depth of the eschar from its outward aspect. To these signs of difference Dupuytren adds, that the pain on pressing the burnt part is much greater when the burn does not involve the whole skin, and therefore the sensitive cutis receives the transmitted impression, than where the whole skin is destroyed, and the pressure is received by the less sensitive cellular tissue. This symptom, however, varies so much in different persons, and is so wholly delusive in children, who are the most frequent subjects of these accidents,[*] that it cannot often establish the diagnosis. If the true skin is involved to any extent, it is best to give a guarded answer when consulted as to the probability of deformity resulting, at least until the separation of the slough enables us to judge of the depth of the mischief. When the whole skin is destroyed, it is only by the greatest care that contraction can be prevented; and when the

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[*] The extract from the Registrar-General's report, above given (p. 723), proceeds as follows: "Upon analysing the 2909 deaths by burns and scalds, there were of

Males between the ages of five and ten	275
„ under the age of five	799
Total	1074
Females between the ages of five and ten	528
„ under the age of five	672
Total	1200

Total males and females under ten years 2274; leaving the small proportion of 635 for both sexes above the age of ten." (Loc. cit.)

destruction involves any large portion of it, some amount of contraction is inevitable.

The deeper burns are far less common, and the total carbonisation of a member, which constitutes Dupuytren's sixth degree, is fortunately hardly ever met with, except occasionally in the fingers and toes, since in thicker parts it requires exposure to the flame for a period which almost involves the necessity of the patient having been utterly insensible, or forcibly hindered from moving his limb, as in the case quoted by Dupuytren from Roche, where a young man had his leg jammed into a vessel of molten metal, from which he could not extricate it. In these deep burns the surface is utterly insensible, charred, and brittle. The skin is sometimes shrivelled up, allowing the dried fasciæ or tendons to be seen through it; and the parts so charred may be broken away without pain to the patient. In the burns of the highest degree, any part or the whole member may be removed within the area of the burn without the patient being conscious of it.

Etiology. The causes of burns and scalds exercise some influence on the progress of the case, and consequently should always be taken into account in the prognosis. The most common, and unfortunately also one of the most fatal, accidents of this nature, is the prolonged application of flame to a large part of the body by the clothes catching fire. This cause furnishes a considerable proportion of deaths to the yearly returns of all our hospitals, and is very fatal in children. The sudden explosion of gases is another common injury; and, however superficial such burns may be, they should never be looked upon lightly, as the extensive interference with the functions of the skin which is thus caused is liable, as we shall presently see, to be followed by grave consequences, even in cases which do not prove immediately fatal from the shock and pain of the accident. The contact of molten and red-hot metals, and of substances at a high temperature, which also act chemically on the tissues, is a cause of very deep burns, which are sure to be followed by sloughing. In explosions, the mechanical violence done to the part has also to be taken into account: and in those of gunpowder we must remember that the unconsumed grains of the powder are projected into and stick in the skin, conjunctiva, &c., and should be removed when practicable.

The heat of the sun, 'insolation,' as Dupuytren* terms it, is asserted by him to be occasionally the cause, especially in hot countries, of severe burns, several cases of which have, he says, been put on record, in which severe inflammation ensued, followed by gangrene and death on the fourth or fifth day. No reference is given, and I am not aware on what authority this fact rests. The only instance which I ever saw of a person being so severely scorched by the sun's rays as to require medical attendance, was during the almost tropical heat of the summer of last year (1859) in London, when a young lad who had been exposed to the sun naked for some time while bathing, was admitted into St. George's Hospital, with the whole of the skin of the back burned in the first degree, and large bullæ raised upon the scapulæ. He, however, recovered speedily.*

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* Loc. cit. p. 506.

Scalds are usually less severe accidents than burns, as the heated fluid generally remains only a short time in contact with the part; so that many of them escape sloughing. Their extent, however, often compensates, as it were, for their superficiality; and special circumstances render certain scalds even more deadly than the other varieties of these frightful injuries. I allude especially to those scalds of the larynx which are not uncommon in infants from swallowing boiling water, or inhaling steam from the spout of a kettle (see INJURIES OF THE NECK).

Very deep and formidable injuries are often produced in manufactories by persons falling into, or being scalded by, liquids denser than water, and which retain their fluidity at a point higher than that at which water boils. These dense fluids seem to adhere to the skin, and run down it, causing a sort of serpiginous sloughing ulcer, very difficult to heal on exposed surfaces, but which is liable to follow the flexures of the limbs, and then is apt to be succeeded by adhesions limiting their motion.

Another point of importance in reference to the causes of burns is, that various bodily conditions, principally connected with morbid states of the brain, often occasion the accident. Thus epilepsy, apoplexy, fainting-fits, and such-like affections, are very common causes of burns. Drunkenness, also, is a frequent occasion of this, as of every other accident, and is very liable, under the combination of prostration and pain which follows a severe burn, to give rise to delirium tremens. I am not aware that in epileptics the disease is usually, or even often, aggravated by the accident; at least, I have seen several cases in which no such effect was produced; nay, it has even been proposed to treat epilepsy by 'firing;' a proposal little likely to find favour in the present day.

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* See *British Medical Journal*, 1859, p. 579.

When, from any of the foregoing causes, such as coma, intoxication, or the fumes of charcoal, complete insensibility has been produced, it is possible that the whole body should be consumed gradually if the clothes accidentally catch fire. The sufferers from this accident are always very fat; and it is to this circumstance, and not to any fancied combination of alcohol with their tissues, that Dupuytren is inclined to ascribe the possibility of so singular an event. The skin is dried, charred, and cracked by the heat, the subcutaneous fat is in the mean while melted, and then pours out from the cracks in the skin, feeding the conflagration, and extending it in a similar manner to other parts of the body, till at length all that is left of what was so lately a human body is a few ashes, and perhaps some melted fat. This is what is called 'spontaneous combustion;' an accident rare in any form, and which appears never to occur really spontaneously, but always as the consequence of a burn. The subject is most graphically treated in the *Leçons Orales*,* to which I would refer the reader for the arguments and details relating to a fact which is too remote from ordinary experience to possess much practical interest.

Finally, I may add that burns are sometimes produced by the action of lightning; but the burn is not usually a prominent feature in such accidents. The whole subject of accidents from lightning will be considered further on.

Prognosis. The prognosis in burns and scalds depends in general on the age of the patient, the extent of the injury, and its depth; and the importance of these particulars may be estimated in the order in which I have stated them. Children are peculiarly liable to the numerous secondary visceral complications which will be pointed out as being frequent sequelæ of burns, and are especially ill-calculated to resist them; so that the risk of cerebral or thoracic affections in children is out of all proportion greater, even after comparatively slight injuries, than in grown people: and it need hardly be said that the opposite extreme of life is a condition in which its impending termination is liable to be hastened by any injury, however slight. Hence, in both the prognosis is unfavourable. The extent of surface involved is a very essential feature in the case. Even when the burn is only of the first or second degree, the shock of the application of fire to a large surface, and the intolerable pain which it occasions, renders the prognosis doubtful; and where the substance of the cutis is involved over a large part of the body, and suppuration must take place along the whole extent of the wound, the chance of recovery is very small. The other primary considerations, by which I mean considerations which influence our judgment as to the probability of death or recovery, are the situation of the injury, and the length of time which has elapsed since its infliction. Burns and scalds of the chest are of all others the most fatal, particularly in children; those of the abdomen are often followed by peritonitis, those of the neck by laryngeal inflammation. Burns of the scalp are very liable to erysipelas and diffuse inflammation, but are not, as far as I have observed, so often followed by cerebral mischief as we should have expected.* When limited to the extremities or to the back, where the thick muscles serve as a protection to the subjacent viscera, these injuries are far less fatal. The lapse of time is always a favourable feature in the case, since the mortality from burns exhibits a progressive decline as we advance farther from the accident. But it must not be forgotten that the period of the separation of the slough brings with it peculiar dangers in burns of the fifth degree, from hæmorrhage and the exposure of the great serous or synovial cavities.

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* Loc. cit. p. 513.

Besides, however, the question of life and death, there is the very important consideration of the local result. Will the ulcer which is left be curable? What is the prospect of deformity from cicatrisation? These questions will be more conveniently discussed in considering the treatment of each degree of burn.

Symptoms. The first and most prominent, and perhaps also the most important symptom in a burn, is *pain.* No other of the many terrible injuries which it is the duty of surgeons to study approaches these in painfulness; and it is a merciful provision of nature which renders the prolongation of life impossible under the torture of a very extensive and deep burn. In cases somewhat milder than these the pain varies very much, both in severity and duration, in different persons and in different degrees of the injury. As a general rule, the deeper kinds of burn are not so painful as those in which a portion of the true skin has been involved, but yet the sensibility of the organ of touch has not been exhausted by the carbonisation of its whole thickness. The pain, however, in almost every case is very severe, and ought, at least in adults, to be promptly met by the exhibition of a very large dose of opium, before any other measure is taken. It will usually subside rapidly after this (although it seldom disappears), on the application of some of the nonconducting substances in common use as dressings, but occasionally resists all such means, and requires fresh doses of laudanum, sometimes often repeated. In burns confined to a limited spot no other symptoms are produced besides the pain and local injury, except some temporary quickening of the circulation from excitement; but it is not of these that I wish to speak here, so much as of those which Mr. Crompton* calls 'constitutional burns.' Here the effect on the general system is shown at once by extreme prostration (especially if the pain have been intense and long-continued), pallor and a peculiar terror, which frequently lasts some time in children. Delirium is often an immediate consequence of the accident. Rigors very frequently occur, and mark a severe form of the injury. The intolerable heat of the burnt part is soon replaced by a distressing chilliness, the consequence probably of suspended or obstructed circulation. The pulse is quick and weak, the tongue and mouth often dry, and thirst great. These latter symptoms are more severe, and great dysphagia may exist, when, as is often the case, the flame has passed into and scorched the mucous membrane of the mouth and pharynx. In this stage of collapse the patient often dies without making any effort at rallying. Death is sometimes ushered in by convulsions or delirium; at others the functions of the great nervous centres remain unimpaired, or the congestion of the brain is manifested by drowsiness, and occasionally by vomiting.

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* A remarkable instance of the immunity which the brain often enjoys, even in very severe burns of the head, may be found in Dr. Hayward's *Surgical Reports*, Boston (U. S.), 1855, p. 264. A still more singular example of the same fact is exhibited in a preparation in the Museum of St. Bartholomew's Hospital (Series I. No. 100), the skull of a lunatic, who had put his head into the fire for the purpose of committing suicide. A third part of the skull has exfoliated, but the brain has not suffered in the least; and the man survived twelve years.

This stage of prostration, or of congestion, as it has most appropriately been termed, lasts a variable time (two days being arbitrarily assumed as its limit, a limit which exceeds the reality in ordinary cases), and is followed by a period of reaction, in which, if at all, acute inflammation is to be apprehended. There is now often some degree of general fever, but this is by no means a constant symptom. The bowels are generally constipated at first, and this constipation in many instances soon gives place to diarrhœa.

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* Loc. cit.

Vomiting often persists, and sometimes exhausts the patient. This symptom, combined with diarrhœa and blood in the motions, is usually considered symptomatic of ulceration in the duodenum. Diarrhœa by itself is a very uncertain indication of any precise anatomical lesion; it is, however, a symptom by no means to be neglected, as it seems frequently to exhaust the strength with a rapidity more than proportioned to its apparent violence. When it is not accompanied by mechanical lesion of the gut, or acute enteritis, it is usually under the control of astringents, which should be combined with laudanum and alcoholic stimulants. The symptoms of thoracic inflammation, which occur generally about this period, are very frequently obscure; limited, perhaps, to slight cough and dyspnœa, even when the lungs are extensively hepatised. Sometimes, however, when the pleura is affected, especially by the irritation of a burn on the chest, the pain is very severe. The sloughs which form in the deeper burns are now separating, and the discharge from them adds to the weakness which is characteristic of all periods of these injuries, more especially, however, the first and last. Hæmorrhage sometimes occurs on the separation of the sloughs when they are in the vicinity of large vessels, or even earlier, from the force of the blood breaking through the charred tissues, and may prove fatal. Thus a man was brought into St. George's Hospital several years ago who had burnt the back of his throat with a red-hot poker in performing some juggling tricks. It was on the second day after the accident that bleeding first occurred from the right internal carotid, and returned on the day following with such violence, that although the common carotid was secured, and no further bleeding took place, he sank rapidly. Arterial hæmorrhage is, however, very rare in burns. I find no other case noted in the Hospital Case-book, which extends over sixteen years, and contains the history of every patient who has been examined after death. The cause of this rarity is, doubtless, that the large arteries lie under the protection of strong fasciæ, which are very seldom burned through, except in injuries so severe as to destroy life before the time at which hæmorrhage would come on.

The limits which separate the second period, that of reaction and inflammation, from the third, that of exhaustion or suppuration, are even more arbitrary than those which mark the passage from congestion to reaction. I shall follow other writers in taking the end of the second week as the termination of the second period for statistical purposes; but it must be understood that in each individual case the third stage is reached after the sloughs have separated, and the process of suppuration has become fairly established from the whole surface of the wound. In this third period, internal inflammations, though not so frequent as in the second, are by no means rare. They are still more decidedly of the asthenic form, and are often entirely latent, being revealed from time to time in the post-mortem examination of patients who appear to have sunk from pure exhaustion. The general symptoms are usually those of weakness merely; sometimes the bowels continue irritable for a considerable time; occasionally, in children, convulsions come on at a late period of the case when none had occurred earlier. The various complications to which these, like other wounds, are subject, may come on at any period. Tetanus, erysipelas, and diffuse inflammation are not, as far as I have observed, more frequent complications of these than of other accidents; while pyæmia is decidedly rare. As the case progresses, the local phenomena gain in relative importance upon the constitutional, until at length an old burn terminates as a case merely of vicious cicatrisation or obstinate ulcer. In this stage it may last an indefinite time, or remain absolutely incurable.

Burns are liable to prove suddenly fatal at all periods of their course; though this accident becomes more rare as the injury becomes more remote. The most common cause of sudden death at the commencement of the case is convulsions in children, in whom this complication is usually, if not solely observed. After the fourth or fifth day death may be produced suddenly by an ulcer of the duodenum perforating an artery or the peritoneum. Some rare cases prove fatal at various periods from causes which baffle pathological inquiry. In some of those cases ulcers of the duodenum have been found, and vomiting has preceded death; but this hardly accounts for the rapidly fatal and unexpected seizure.

Pathology and Treatment. The treatment of burns divides itself naturally into two very different parts, the local, and the constitutional. The former is best determined by experience, and by attention to the general rules of surgery; for the latter a knowledge of the remote consequences of these injuries is required, which can only be obtained by post-mortem investigation.

I shall, therefore, endeavour to set before the reader more fully than has been done elsewhere, as far as I can discover, the pathology of these injuries, with a view to determine the viscera or functions which are more peculiarly threatened, the causes and modes of death, and hence the indications for their constitutional treatment.

The pathology of burns has been more closely studied, and the importance of the remote lesions which they produce in the viscera has been more accurately appreciated, since Dupuytren* called the attention of the profession to the prevalence of inflammation of the gastro-intestinal mucous membrane, and Mr. Long† gave precision to this observation by pointing out the ulceration of the duodenum which so frequently accompanies severe burns. The only pathological researches, however, with which I am acquainted, which are at once accurate and extensive, are those of Mr. Erichsen,‡ who has tabulated fifty fatal cases of burns and scalds with a view of determining the organs most frequently affected in each degree and period. I shall make frequent reference to this valuable table, and to another similar table in my own possession, compiled from the case-books of St. George's Hospital, and containing a full account of the history and post-mortem appearances in seventy-five fatal cases.

As the method and principal cause of death is a point of the greatest importance to ascertain, in order to determine the general direction which our treatment should take, I have examined the notes of those seventy-five cases with a view, if possible, of deciding this point. Mr. Erichsen's table does not contain the symptoms during life, and is therefore not available for this purpose.

Seven cases must be deducted, in which the history does not enable us to draw any positive conclusion, or where the patient died of some other disease. Of the remaining sixty-eight, nine died of shock, all within two days; seventeen of exhaustion, accompanied in some cases by visceral lesion, but without any striking functional disturbance. Five of these cases proved fatal within a week, but the majority survived for a much longer period. Erysipelas was seldom noticed, and proved fatal in only three instances, in all of which the scalp had been burnt. Pyæmia is a rare accident in burns, as might have been anticipated from the fact that the bones are rarely injured, and that phlebitis is almost unknown. It occasioned death in three cases, one of which, however, was somewhat doubtful. Two died of tetanus. Thus thirty-four, or exactly half the cases, died of affections of a low type not depending on local mischief or visceral disease.

Passing on now to the affections of individual organs, we find that the brain was the seat of fatal mischief in eleven cases. All of these were children, and nine of them under five years of age. The death usually took place soon after the accident, but in three cases the fatal seizure did not occur till a late period. The brain was in most cases found congested and wet; in two inflammatory softening existed.

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* Op. cit. pp. 521-525.

† *London Medical Gazette*, Feb. 1840

‡ Ibid. Nos. 789, 790.

Six cases died from inflammation of the larynx or trachea; five of the patients were children; one a woman seventy-eight years old. They all died within two days, except one, who survived till the third. Tracheotomy was tried in two cases, and in one was thought to have prolonged life.

Twelve died from thoracic complications. In all of these the chest, or its immediate neighbourhood, was injured; all, except four, were children. The periods at which the cases proved fatal were very various.

Four only died from the direct effects of abdominal lesions, and in one of them the manner of death was obscure. One was a case of peritonitis, occasioned by a deep burn on the abdomen. Two others died from sudden hæmorrhage in ulcers of the duodenum. The period of death was ten and five days respectively. The fourth case was one of those obscure instances of sudden death which sometimes occur in these injuries. The patient had gone on satisfactorily for more than ten weeks, and was then seized with vomiting, which proved fatal on the same day. Nothing was found to account satisfactorily for the rapidity of the death; but, as the duodenum was found extensively ulcerated, it is classed in this category. It is most probable that the vomiting was connected with this ulceration, and death might have been induced by some affection of the great sympathetic ganglia in the neighbourhood. This is a point, however, on which it is not worth while to theorise here. We are only concerned to remember that these sudden and obscure deaths are not very uncommon in burns, and have been noticed by many authors. Hence it is always prudent to be a little reserved in our prognosis.

One case remains to be accounted for; in this the patient died of hæmorrhage from the internal carotid artery.

The above facts show how much more common, especially in adults, is death from shock and from exhaustion than from any internal inflammation, and how nugatory antiphlogistic measures and severe regimen must be, which are directed against apprehended inflammation; measures at all times of doubtful utility in checking such inflammation, while they cannot fail to aggravate the tendency to exhaustion, which is so much more to be apprehended, and so much more likely to prove mortal. The actively fatal inflammations of the peritoneum, pleura, and lung are hardly ever met with, except in lesions of the parietes which enclose them. Adults hardly ever die of any other cerebral affection after burns than delirium tremens.

Pathology of the first period. Of the cases of burn that prove fatal, a great majority die in the *first period* of the disease, that is in the first two days after the injury; before there has been, in general, time for the occurrence of inflammation.

Mr. Erichsen's table contains sixteen such cases, and my own, nineteen; *i. e.* thirty-five, out of 125 cases in which post-mortem examination was performed, had died on the first or second day of the injury: but as the great majority of those who are thus 'burnt to death' are not examined, we may be sure that the proportion is much greater than this. Thus, in the same period (sixteen years), during which the seventy-five cases above referred to occurred, 119 other fatal cases of burn were brought into St. George's Hospital; of which seventy-nine died in the first period, twenty-six in the second, and fourteen afterwards. The cause of death in the large majority of these cases is shock; a somewhat vague term, which has been variously interpreted by different authors. Dupuytren imagined that death, in the early period of burns, is produced frequently by excess of pain,* and thus explained the occurrence of death by shock; but this explanation can hardly be considered as worth much, since it leaves us as much as ever in the dark as to the mode in which death is brought about. It seems more natural to attribute the fatal result to the disturbance of the internal circulation, produced by the sudden check to that through the superficial vessels. Congestion of the brain and mesencephalon, among other viscera, is thus produced, which manifests itself in a suspension of the functions of those great nervous centres.† This view derives all the confirmation which anatomy can give it, from the fact, that some unnatural congestion of the brain is always, or almost always, found in examining the bodies of those who die at this period. Of Mr. Erichsen's sixteen cases, "the brain and its membranes were found congested, with more or less serous effusion into the ventricles, or arachnoid, in fifteen cases." The other was not examined. I have not myself found this appearance quite so uniformly, but the results of my table are sufficient to give a general support to Mr. Erichsen's views, as in those cases where the brain was examined (unfortunately only very few), I find only one in which it is asserted to have been healthy in respect of structure and vascularity. Congestions of the other viscera are also very common, or rather, internal congestion is probably always present, although it is not always possible to recognise this condition by post-mortem examination. Thus, of Mr. Erichsen's sixteen cases, thoracic congestion was noted in eight, and in six of my nineteen cases; while the congestion had passed on to demonstrable inflammation in one of the former, and in three of the latter: or, in general language, there were traces of thoracic congestion in one-half of the cases examined. Those who have observed how frequently the tissues (and more especially the mucous membranes) lose after death all traces of the congestion, which we know from infallible signs to have existed during life, will not hesitate to admit from this evidence that there is a great tendency to congestion of the thoracic viscera in every case of severe burn. Of course this tendency becomes more formidable in proportion as the burn approaches nearer to the situation of those viscera. Congestion of the abdominal organs is less frequently met with, although by no means uncommon, since twelve out of Mr. Erichsen's cases displayed this condition. Among my cases, however, it is noted in only three instances; in one of which it had advanced to such an extent as to produce extravasation beneath the mucous membrane of the cæcum.

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* Op. cit. p. 518.

† See Erichsen, loc. cit.

Another extremely common seat of congestion is in the mucous membrane which lines the pharynx and larynx. This is, no doubt, at least in the great majority of cases, the result of the inhalation of flame or heated air during the accident. Of the nineteen cases in my table, which died during the first period, only six wanted some appearance of congestion in this part. The congestion in the pharynx very generally ceases abruptly at the commencement of the œsophagus; in some rare cases, however, it extends into the stomach. It frequently gives rise to inflammation and effusion in the submucous tissue about the fauces; but I do not find among my notes much reference to symptoms dependent upon this condition, except an occasional notice of dysphagia, and it is of subordinate importance.

Not so, however, the same condition in the larynx, which often co-exists with the congestion of the pharynx. This is very apt to produce œdema glottidis, spasm of the glottis, and all the fearful consequences which follow it. Nine out of my seventy-five cases presented traces of inflammation of the larynx, which in three of them seemed to have been the sole cause of death. In the scalds of the glottis, to which children are so liable from inhaling hot water or steam from the spout of a kettle, this condition inevitably occurs, and is very fatal. If emetics and the moderate use of antimony do not very shortly improve the state of the breathing, laryngotomy is the only resource; one which too often proves unavailing. The reader will find this point more fully treated under the head of INJURIES OF THE NECK. Besides these nine cases, three died of inflammation seated lower down, in the trachea.

So much for the post-mortem appearances in the first period. What indications are to be drawn from them? The existence in all the most important viscera of extreme congestion, which passes on very rapidly to inflammation,* may be, and has been, taken to be an indication for so-called 'antiphlogistic' measures; and accordingly we hear of bleeding from the jugular vein to obviate cerebral inflammation; of leeches, to prevent abdominal complications; of bleeding from the arm, to guard against pneumonia; of mercury, tartar-emetic, and low diet. Now, without going so far as to assert that cases may not occur in which such measures may be useful in the period of inflammatory reaction, I believe that the theory which would recommend them in the first stage of the injury is an erroneous one. The congestion is due to the sudden revulsion of blood from the surface, by which the heart is oppressed, and the stagnation thus perpetuated. The congestion, in a word, is passive. To remedy this mechanically, by taking blood out of the veins, is, I believe, impossible; and, indeed, the state of prostration in which the patient is always found is such, that I never saw a case in which any such proposal was made. Nor is any reduction in the mass of blood desirable, since the patient will soon be in a condition in which he will require all his strength. Diffusible stimulants afford, I believe, the means most likely to succeed in arousing the powers of the circulation, and restoring the succession of those vital changes in the great nervous centres on which the patient's chance of surviving depends. The depression, coldness of the surface, and sinking, should be combatted by warmth to the surface, generous diet, and small but frequently-repeated doses of alcoholic stimulants and ammonia. These must of course be given cautiously, since sthenic inflammation of the thoracic viscera may supervene; but they may be pushed till the strength of the pulse rises to the standard of health; and, as it does this, its frequency will probably be found to diminish. Opium is of great service in the period of pain, terror, and depression which follows severe burns in adults, and may be given liberally. In children, in whom the tendency to congestion of the brain is so marked, it should be used cautiously, if at all.

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* I have notes of several cases, in which effusion of lymph was found on the day after the accident.

Pathology of the second period. The second period is more peculiarly that of inflammation, and is usually held to commence at the end of the second day, and to extend to the end of the second week. During this period, twenty-nine out of my seventy-five cases died, and twenty-five out of Mr. Erichsen's fifty; or fifty-four cases out of 125. The visceral affections at this period are principally of the brain, lungs, and intestines; since the cases in which the larynx is injured usually die earlier. Of Mr. Erichsen's twenty-five cases, the brain was affected in fourteen; eleven being simple congestion,* and three serous effusion. Of my own twenty-nine, the brain was left unexamined in the great majority; and this, I conclude, was in consequence of the absence of cerebral symptoms. Three, however, are noted, in which the occurrence of convulsions or obstinate vomiting drew attention to the brain. It was found congested in all, with effusion of fluid into the ventricles, or arachnoid; but there was no evidence of true inflammation in any case.

The lungs are more frequently affected. Thus, in Mr. Erichsen's table the lungs were congested in ten cases, and inflamed in five. Out of my own twenty-nine, inflammation of the lungs or pleura had occurred in seven cases (in one, however, it was believed to have existed before the accident), and congestion is noted in five others.

The lesions of the abdominal organs are of extreme interest, on account of the singularity of the appearances which they present, and the physiological speculations to which they give rise. They are entirely confined to inflammatory phenomena in the gastro-intestinal tube. None of the other abdominal viscera (liver, spleen, or kidneys) are, as far as I have observed or can discover in authors, ever affected as a consequence of burns except in pyæmia. The inflammation of the intestines rapidly passes on to ulceration of their mucous coat, and is so generally limited to the duodenum, that little attention has been paid to lesions of other portions of the intestines or of the stomach, although they do sometimes occur. The earliest period at which I find notes of ulceration of the duodenum is in one of Mr. Erichsen's cases on the fourth day. In my own table, two cases are noticed on the fifth day, and one on the sixth. The whole number of cases in which ulceration of the duodenum was discovered in the second period was, out of Mr. Erichsen's twenty-five, six; out of my twenty-nine, four; to which two ought to be added, in which, though the duodenum was intact, extensive ulceration was found in other parts of the intestine. This gives twelve cases in the second period out of fifty-four. The duodenum in three other of my cases presented enlarged glands; and in one of these the enlargement affected also the glands throughout the whole intestinal tract. Congestion is also frequently found; but its pathological importance appears slight at this period of the disease. The whole subject of abdominal lesions will be resumed further on, with the pathology of the third period. It will be sufficient for the present purpose to state that of the cases in which ulceration occurred, it was unaccompanied by general inflammatory symptoms in any instance; and that where it caused death, that result was occasioned by hæmorrhage.

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* I may remark, that, in the absence of notes of the symptoms during life, no great importance is to be attached to the mere record of 'congestion' of the cerebral vessels after death. Hardly any post-mortem appearance is so variously estimated.

On consideration of the symptoms which accompany these inflammations, it must be allowed that they contra-indicate the use of active depletion, and that the object of our treatment should be rather to support the patient's strength, and enable him to live through the local action which is probably inevitable. Care, of course, should be taken not to over-feed or over-stimulate a patient with inflammation of the lungs or bowels; but in these, as in all other cases in which inflammation follows injury, the general treatment should be guided by the general symptoms, and especially by the tongue, the pulse, and the state of the skin; and if the pulse is weak, and the surface cold, stimulants should be prescribed, with generous diet if the condition of the tongue allows of it, even though the patient is known to be affected with thoracic or abdominal inflammation; while in the opposite state of the system it may be proper to pursue the antiphlogistic regimen. The surgeon must be guided in this, as in so many other matters, more by common sense, and a competent knowledge of the principles of his art, than by rule and theory. In the practice of our metropolitan hospitals we have frequent opportunities of witnessing the success of the stimulating treatment, even in cases of acute visceral inflammation; and such treatment has now become common in the hands of many of our best physicians; while in a different air, and among people of a different constitution, the antiphlogistic plan may be indicated, and may prove successful. Experience and tact will decide the question in each case; but there can be little danger in asserting that bleeding, low diet, mercury, and tartar-emetic, are not likely to obviate ulceration in persons of weak constitution and irritable circulation; and that, as far at least as the abdominal complications are concerned, they are more under the control of stimulants combined with opium. The thoracic inflammations are still more difficult to deal with. I have notes of a case in which fatal pleurisy supervened directly after, and very probably in consequence of, free stimulation, which nevertheless was necessitated by the general condition of the patient; while, on the other hand, my notes tell of several cases in which, notwithstanding the known presence of inflammation of the thoracic viscera, it was impossible to use depletion on account of the patient's debility. Local antiphlogistic measures, combined with general stimulants, offer the best prospect of success in these difficult, and generally unsatisfactory cases. I have seen instances in which some good seemed to result from the combination of moderate doses of tartar-emetic with the stimulating regimen.

Pathology of the third period. If we pass now to the third period—that which is called the period of suppuration or exhaustion —we shall find that the causes of death are by no means limited to the exhaustion either of profuse discharge or of protracted suffering, but that inflammation enters largely into the category. As to the proportion of deaths which occur at this period, Mr. Erichsen's table and mine are somewhat at variance, his giving only nine out of fifty, less than one-fifth, mine twenty-seven out of seventy-five, more than one-third.

The lesions of the brain which are met with at this period are not very important, and are in fact, so to speak, accidental, being limited almost entirely to cases of infantile convulsions and pyæmia. I shall therefore dismiss them, as requiring no special consideration.

The chest is more frequently affected in cases of injury to the thoracic walls, and this affection is a very frequent cause of death. In Mr. Erichsen's table, lesions of the lungs and pleura are noted in six cases out of nine. In four the appearances were distinctly inflammatory, and in the two others there was congestion, with effusion into the pleural cavities. In my collection, out of twenty-seven cases, morbid appearances are noted in the lungs in ten; and in eight of these the inflammation, if not the sole, was at any rate a principal cause of death. The diagnosis of the presence of thoracic inflammation is not always easy, since the burn is usually situated on the chest, and precludes the possibility of physical examination; but hacking cough, bloody sputa, or pain in the chest, will direct attention to the lungs or pleura, and set the Surgeon on his guard. The indications for treatment, however, are perplexing in the extreme, since weakness is a more prominent feature than in the second period. Indeed, all means of treatment will usually fail, and the cases must be looked upon as almost hopeless.

Lesions of the abdominal viscera are frequently met with during the third period of burns. Out of the twenty-seven cases in my table proving fatal during this period, there were six in which open ulcers were found in the duodenum, one in which a similar ulcer was found cicatrised, one in which the whole mucous membrane of the small intestines was found inflamed, but not ulcerated, and one in which the duodenal glands were found enlarged. Mr. Erichsen, however, found no instances of ulceration of the intestines among the nine cases in his table.

This ulceration is a sufficiently common phenomenon in every period of burns and scalds. Of the 125 miscellaneous fatal cases from which this account has been compiled, sixteen presented ulceration in the duodenum, five of which died during the first week (four days being the earliest period), five in the second week, and the other six after longer periods, one as late as the seventy-fifth day. The patients' ages varied as much as the period of death: four were children of the ages of 5 or 6, two young adults 19 and 27 years of age; two in the middle period of life, 36 and 42 years old; and two aged persons, 66 and 78 years of age. The situation of the burn was very various. In two cases the extremities only had been burnt; but in all the rest some part of the trunk (chest or abdomen) had suffered. The appearance is that of a perfectly indolent ulcer; it is usually seated just below the pylorus; often there are two or three close together; the edges of the ulcers are not raised nor everted; there is little or no evidence of vascular action or inflammatory effusion in their neighbourhood; when they are recently formed, they look simply as if a portion of the mucous membrane had been cut out. But when the ulcer has penetrated more deeply, so as to threaten perforation of the gut, lymph may often be found effused on its peritoneal surface; a natural barrier, apparently, to the fatal progress of the disease. Sometimes the glands of the duodenum may be found enlarged; but though this appearance is sufficiently common in all cases of burn, it does not appear that it is at all a constant accompaniment of those in which ulceration exists. It has been assumed rather than proved, that the enlargement of the glands is the first step in the ulceration. It is quite possible that it may be so; and the theory, which was first broached by Mr. Curling,* on the suggestion of Mr. Bowman, is, that the strain thrown upon the intestinal glands, especially Brünner's, in separating the watery material out of the blood which accumulates in it from the suspension of cutaneous perspiration, is the cause of the diarrhœa and ulceration. This is the only rational explanation yet offered of the pathology of this lesion; but it is purely conjectural.

If we inquire into the symptoms of ulceration of the duodenum, we shall find the results principally negative. In the large number of cases which are comprised in these tables, and which have been observed by persons sufficiently competent and careful,† I can find no evidence that the *accession* of this ulceration is announced by any unmistakable symptoms. No pain appears to be complained of in the part, nor is it noticed that the region of the duodenum is tender to pressure. Diarrhœa is not constantly present, nor when present is it by any means decisive of the point. Vomiting does indeed frequently occur in the early stage of ulceration of the duodenum, but it is as often symptomatic of cerebral as of intestinal or gastric irritation. We are therefore left, to a great extent, in the dark as to the early symptoms of this affection; and all that we are entitled to say upon this subject is, that the occurrence of obstinate diarrhœa and vomiting should always direct our attention to the stomach and duodenum; that careful palpation of this region may sometimes assist our diagnosis; and that the presence of blood in the evacuations is strongly confirmatory of it. When the severe symptoms, which are occasionally noticed, come on, intense pain, copious hæmatemesis or melæna, distension of the abdomen, rapid sinking, we may be sure that the ulcer has proceeded to perforate either the peritoneal coat of the gut, or some considerable vessel (probably the pancreatico-duodenal artery),‡ and that the case is beyond the reach of remedies.

The diagnosis, then, being so obscure, what is the prognosis?

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* *Med.-Chir. Trans.* vol. xxv.

† The notes in my cases were taken by myself for five years, and by the other Hospital Registrars for the time being. In Mr. Erichsen's table the authorities are given.

‡ A preparation in the Museum of St. George's Hospital (Series xxxi. Subser. 8, No. 23) shows a large branch of the pancreatico-duodenal artery opened close to the parent trunk by an ulcer of this nature.

It was supposed, when this complication was first pointed out, that it was necessarily fatal; but that this supposition is erroneous, is proved by the records of cases in which such ulcers have been found cicatrised. Mr. Curling gives one such case;* and my notes contain another. In the latter instance, the patient, a child æt. 3½, died on the twenty-eighth day after a severe burn on the chest, arms, and thighs. The proximate cause of death seems to have been pneumonia, combined with exhaustion from suppuration and diarrhœa. A circular patch about the size of a fourpenny piece was found at the commencement of the duodenum, where the mucous membrane was deficient, and the exposed surface cicatrised. It is interesting, as showing the uncertainty of diarrhœa as a symptom in these cases, to notice that here it occurred for the first time on the twenty-third day, when the ulcer must have been nearly, if not altogether, healed. From the facts, then, that cicatrised ulcers are sometimes found in patients who have died of other complications; that the lesion does not of itself produce any symptoms of dangerous disturbance of the health; and that it is frequently discovered in cases where it would never have been suspected, I am inclined to think that it may be present in many of the cases which recover, and that its importance in practice has been exaggerated.

Other parts of the intestines are sometimes, although rarely, affected. My table contains only one case in which the jejunum and ileum were ulcerated, the duodenum being intact. Peritonitis was not associated with it in any case. When the serous membrane is affected, it is always, as far as I can see, the result of local irritation from burn of the abdominal parietes, and affects the low purulent form, rather than the adhesive.

Thus it will be seen that all the inflammatory phenomena connected with the lesions of the intestines belong to the class of low inflammations; that they are not ushered in by any of the local or general symptoms which accompany acute disease; and that when they prove fatal, it is by the secondary consequences of the ulceration (perforation or hæmorrhage), and not from any interference with the function of the gut, nor any impression on the general health.

It may seem absurd to talk about the treatment of an affection which, generally at least, eludes diagnosis. Still, as the frequent presence of ulceration in the intestine has been made a pretext for recommending a more active antiphlogistic regimen in burns, it is right to point out that a more attentive consideration of the question would have shown that the indications are all the other way. If the insidious progress of a duodenal ulcer can be stopped by any remedies before it has opened the pancreatico-duodenal artery or perforated the peritoneum, it must assuredly be by some means different to those which may be used successfully in preventing plastic exudation or restraining vascular action. It is hardly likely that reducing the patient's already exhausted powers can have any other effect than to hasten the progress of the ulceration, and add fresh victims to that 'majority' which already owes so much to the 'nimia medicorum diligentia.' In all stages, then, of the treatment of burns, great caution should be exercised in the use of antiphlogistics; and the only period in which they are admissible at all, unless in very exceptional circumstances (such as some instances of scald of the glottis), is during the second period in thoracic inflammation; and even there, as has been said before, it will be generally found impossible to press the treatment.

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* *Medico-Chirurgical Transactions*, vol. xxv. p. 280.

Local treatment. The local treatment of burns is a subject on which many books have been written, and perhaps more numerous remedies recommended than in any other branch of surgery. The success which is said to have attended very different, and even opposite, modes of treatment shows that the authors must either be misrepresenting the facts or speaking about different matters. I prefer the latter explanation, more especially as I find that authors who have written to recommend certain methods have almost invariably spoken of burns as if they were all alike, forgetful apparently that the essential question in the local treatment of a burn is its depth, or degree, and the consequent probability of sloughing, ulceration, or mere inflammation resembling that of erysipelas. It is only by keeping this point steadily in view that we can hope to arrive at any rational plan for the treatment of these injuries.

1. First degree. In cases of burns of the first degree, little local treatment is necessary, except to keep in contact with them any application which will relieve pain and exclude the air: if, at the same time, it tends gradually to constrict the vessels of the skin, dilated by the sudden stimulus, so much the better. Cold applications are usually more agreeable than warm, lotions than ointments. In hospitals, the usual application is Goulard-water on rags frequently irrigated; cold water does very nearly as well; but a host of remedies are in domestic use—scraped potatoes, ink, moist earth, &c. &c., all of which act on the same principle.

If, however, the burnt surface is very extensive, and the patient is much depressed from fright or pain, it would be injudicious to chill the surface further by cold applications; and then it will be better to wrap the part in cotton-wool, or powder it thickly with flour, or to use some of the stimulating substances which will be enumerated farther on. The new epidermis is formed usually in two or three days, after which no further application is required. The vessels of the skin, however, will remain dilated for some time, as they do after a blister.

2. In the second degree, the principles and details of the treatment are very much the same as in the first, except that care must be taken to preserve the epidermis. It is often (especially in extensive scalds) raised from the skin in very large blebs filled with serum, which adhere to the clothes, particularly when the latter are sodden in water, and are then generally dragged off by the patient's friends in undressing him. This, however, ought always to be avoided when professional aid is early at hand; the clothes should be very carefully cut off, the bullæ opened by a small puncture, and the epidermis smoothed down gently upon the skin. It will, if carefully managed, generally remain there till the papillæ are protected by a fresh formation. When the burnt surface has been deprived of its epidermis, the papillæ usually furnish an abundant secretion of pus, and are distressingly irritable and sensitive. Sometimes the papillary tissue may slough from the resulting inflammation, even in cases where it is in no degree disintegrated by the injury. In other respects, the treatment is the same as in burns of the first degree; the best plan, perhaps, being to apply some mild salve (such as calamine cerate) over the burnt surface, and then to wrap the part thickly in cotton-wool.

3. Burns of the third degree are much more serious than the two former varieties of the injury, since here a portion of the papillary tissue has been destroyed, and must slough; and its reproduction, if the extent involved be great, is usually a very tedious process, while during its progress the patient is of course liable to the various complications which may affect any open wound (erysipelas, phagedæna, &c.), as well as suffering from the weakness induced by protracted discharge. The best way of treating burns of this depth, is to dress the sloughing parts with some stimulant application, in order to hasten the separation of the slough. The best with which I am acquainted is the ung. elemi co. of the St. George's Hospital *Pharmacopœia*.* Or turpentine may be used in

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* ℞ Unguent. elemi ℔j.; unguent. sambuci ℥ij.; copaibæ ℥iij. Unguentis

liniment, or mixed with an equal quantity of this ointment. Turpentine is a very valuable application in burns where the surface is sloughy, but is unnecessary and painful in those where it is raw and tender. Carron-oil (a mixture of equal parts of linseed-oil and lime-water) is a deservedly popular remedy; and hosts of other stimulating substances are recommended. The neighbouring part, where the burn is less deep, may be dressed with some mild ointment; and the whole enveloped, until reaction is thoroughly established, in a thick layer of cotton-wool, loosely supported by a bandage. The dressings of a burn should never be changed more often than is absolutely requisite for cleanliness. As the slough loosens at the edges, its loose part should be cut away at each dressing; but it must not be forcibly detached. When it has separated, the exposed surface is left raw and suppurating; generally indented by small pits, from the unequal depth of the slough. The object now is to procure cicatrisation as speedily as possible, since, if the inflammation proceeds unchecked, a crop of prominent, flabby, or fungous granulations will spring up, which are with difficulty brought to heal; or ulceration may proceed at the edges, and widen the sore. I believe the best plan will be to apply moderately firm pressure, as soon as it can be borne, by careful strapping. If the diachylon plaster be found too irritating, soap-strapping may be used, or the plan recommended by Mr. Chapman for ulcers of the leg (water-strapping). I believe, however, that adhesive plaster is the preferable material, and its use affords by far the most efficient and comfortable plan of treating large granulating burns. The strapping is not extremely painful at the time of application, does not require frequent removal, and does not necessitate confinement to bed. I have under my care at the present time an infant, extensively burnt on the back, in whom this treatment was used with great benefit. If this method be contra-indicated, the sore must be treated on the general principles laid down in the essay on ULCERS; but it will be found almost inevitable to recur to pressure in some form, when the granulations have sprouted up and present an extensive suppurating surface, which shows no tendency to heal. Such cases go on for months under every kind of treatment, even when the granulations look healthy. Sometimes

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simul liquefactis et ab igne remotis, paullo antequam refrixerint, copaibam adjice.

The unguentum sambuci is another hospital preparation made of the leaves, in the proportion of 2lbs. to 2½lbs. of fat boiled down with water and strained.

the sore, after being healed for a shorter or longer period, will break out again from time to time; occasionally it remains incurable. In recent cases, repressing the granulations by pencilling either the edges, or, if necessary the whole surface, with stick-caustic, and applying firm pressure with strapping, is the most efficient method of treatment. Sometimes it will be advisable to fix on to the granulating surface below the strapping a piece of thin sheet-lead, or of oiled-silk, cut so as to fit the wound exactly; and it is frequently found beneficial, especially when the discharge is profuse, to dust the surface with some astringent, in fine powder, as starch, alum, calamine, &c.

It is the opinion of some Surgeons (among whom I may specify Mr. Henry, of the Middlesex Hospital*), that in burns which suppurate extensively, death is often due to the mephitic influence of the foul air which is so extensively generated in such injuries. In these cases, no better application can be used than Condy's ozonised liquid, diluted in the proportion of from half a drachm to a drachm in a pint of water. This excellent disinfectant is now in very extensive use in all cases of foul discharge or fœtid exhalation. It has also appeared to me to exercise a favourable influence on the progress of the indolent ulcerating surfaces of burns, apart from its disinfectant action; and thus I employ it frequently as a topical application to burnt surfaces in children.

4. The above observations will also apply to the treatment of burns of the fourth degree; but here a most important additional element enters into consideration, that of the contraction which will accompany and follow cicatrisation. Those who have had even slight practical experience of these cases, need not be reminded of the frightful deformities thus induced: the head drawn down upon the shoulder, the jaw everted and fixed upon the breast, the lips turned out, clear articulation impossible, the dripping and distorted mouth, the rigid twisted limbs, and all the ghastly and hopeless mutilations which so often follow burns in the neglected children of the poor. Whenever, therefore, there is the slightest probability that the whole thickness of the skin has been involved in any part of a burn, cicatrisation ought to be watched with the greatest care, especially if it be in a part where the integuments are loose, and where important organs would be interfered with by contraction, in order to obviate this result as far as possible, by the use of appropriate

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* Clinical Lecture, in *Lancet*, Dec. 19, 1859, p. 580.

extending apparatus. This apparatus should be very carefully fitted, and maintained night and day in position till the burn has healed, and for some time afterwards, as the tendency to contract does not vanish with the healing of the wound. As long as any risk of contraction seems to be present, the scar should be kept stretched, and its extensibility be promoted by keeping it constantly saturated with oil. The ingenuity both of the Surgeon and instrument-maker is called for in these cases, and much success is often obtained both in obviating and curing deformities. But many disappointing and hopeless cases will be met with, in which the use of extension cannot be tolerated on account of the pain and irritation it causes, or in which the patient's strength is so exhausted that he cannot bear the extra call upon it, which is of course necessitated by keeping the wound largely open; or in which the points where counter-extension should be made are themselves involved in the injury. In these we must allow contraction to occur, and only think for the moment of producing as speedy union as possible; or if a limb be the seat of the injury, and the resulting contraction will leave it useless, the first favourable moment for amputation must be chosen. The treatment of contracted cicatrices will be found described elsewhere (WOUNDS, PLASTIC SURGERY).

Little need be added as to the treatment of burns of the fifth and sixth degree. The former, if of any considerable extent and seated on the trunk of the body, are almost necessarily fatal. When the limbs are the seat of injury, and the part involved is large, or when the fingers are burnt, and the consequent sloughing will destroy the action of the tendons and render the finger useless, it is better to amputate at once. Burns of the sixth degree, if the patient survive so as to become the subject of treatment, must be seated on the extremities. Practically they are hardly ever seen, except where the thickness of the soft parts is trifling, as on the fingers, dorsum of the hand or foot, &c. Most of them require primary amputation; the necessity depending on the extent of the burn, and the conditions which will follow the separation of the sloughs.

It is hardly necessary to say any thing about the indications for secondary amputation in burns on account of incurable ulceration, or contraction of the limbs, as these are questions rather of common sense than of precedent or theory; and where large joints are opened by the separation of the slough, the case does not differ materially from any other of gangrene with similar complication.

Accidents from Lightning.

Accidents from lightning are very rare in this country,* and it has never fallen to my lot to witness any which called for serious surgical treatment; nor does it seem to have occurred to those of our countrymen, whose experience of this form of injury in tropical climates may have been greater than ours, to give the profession any systematic account of the matter. I must therefore apologise for the necessarily secondhand character of what follows on this head. Sir Benjamin Brodie, in his *Lectures illustrative of various Subjects in Pathology and Surgery*, has treated the subject with his usual clearness and felicity; but only so far as to show the manner in which death is produced by a stroke of lightning, and the means to be used in order, if possible, to save life. The most complete account which I have been able to find of the minor, but still very serious, symptoms which sometimes follow these injuries, is contained in Boudin, *Géographie Médicale*, Paris, 1857, vol. i. pp. 499 et sqq. An abstract of M. Boudin's researches may be found in Althaus, *Medical Electricity*, London, 1859, Appendix. From these sources and from a number of cases recorded in old volumes of the *Philosophical Transactions*, the following account has been chiefly compiled.

A person struck by lightning is usually more or less completely deprived of consciousness at the time. This is a consequence sometimes of the shock given to the brain, and is accompanied by more or less paralysis of motion and of sensation, common or special. Sometimes, and perhaps more usually, it is the effect merely of fright, and is then only transient. The insensibility sometimes lasts for a considerable time; as in a case recorded by M. Boudin, in which a gentleman having been struck by lightning remained for an hour and a quarter without (as the bystanders affirmed) any sign of life, and then recovered on being exposed to a pelting shower of hail. The paralysis by which it is usually accompanied may last for an indefinite period. In the above case the patient did not entirely recover for more than four months; and in one recorded in the sixty-third volume of the *Philosophical Transactions*, weakness and numbness were still felt three months after the stroke. This paralysis is more common in the lower limbs than the upper.

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* M. Boudin calculates the number of deaths in England at twenty-two per annum; and the total of accidents at about double this number.

Other affections caused by lightning are: burns, more or less extensive; eruptions of erythema or of urticaria, which are said by one author to have reappeared afterwards with each succeeding thunderstorm; loss of hair over parts or the whole of the body; wounds; hæmorrhage from the mouth, nose, or ears; loss of sight, smell, speech, hearing, and taste, or, in rare cases, exaltation of these special senses; cataract; imbecility; abortion. Another curious effect of lightning, which seems to be testified by so many independent authorities that it must be accepted as true, is that it sometimes leaves an image of neighbouring objects (as if by a process of photography) on the body, even on parts covered by clothes.

Many of the recorded cases of injury by lightning are very curious and interesting; but, as the foregoing list will show, the symptoms are too miscellaneous, and their method of production too obscure, to be brought under general rules; and it would lead us too far from ordinary practice to attempt to dwell minutely upon them. It may suffice to say that persons not killed on the spot usually recover, though a few cases are on record in which they have died of exhaustion; and that recovery is apparently hastened by the administration of tonics, especially quinine, and gentle action on the skin by means of baths. In the case of protracted convalescence already referred to, the patient on coming to himself found that he had completely lost the sense of sight, and that he could hardly feel any of his limbs, and could not move them. He was also severely burnt on various parts of the body. In this case, as the power of motion and the sense of sight returned, the patient was tormented with pains in the limbs and head. These were relieved by galvanism, which was thought also to have hastened the healing of the sores left by the burns. The loss of hair, which is sometimes produced by the action of lightning, is a phenomenon more commonly noticed in the lower animals, who, it may be remarked, are much more exposed to damage in thunderstorms than human beings, even under the same circumstances. Sir B. Brodie has referred to a curious story, in the *Philosophical Transactions*, of two bullocks, pied white and red, who were struck in different storms. In both cases the white hairs were consumed, and the red escaped. The following anecdote, however, related by M. Boudin, shows that in men also loss of hair is sometimes produced by flashes of lightning. The frigate *Golymin* was struck by lightning on the night of February 21, 1812, and the captain, M. Rihouet, received several wounds on the head. "The next day," says that officer, "when I went to shave myself, I found that the beard, instead of being cut, was torn out by the action of the rasor; and since that day it has totally disappeared. The hair of the scalp, eyelashes, eyebrows, and surface of the body fell off successively. Since then I have remained entirely hairless. During the year 1813, the nails of my fingers scaled away. Those of the toes experienced no visible change."*

The burns caused by lightning are sometimes deep and very obstinate in healing;† sometimes, on the contrary, they amount merely to vesication, or even only to discoloration. They will be treated on ordinary principles, unless indeed the authority of the case above alluded to should induce the Surgeon to make trial of the effects of electricity, which is said sometimes to produce the healing of ulcers due to other causes, and which have resisted the ordinary modes of treatment.

Mutilations of the body are only rarely met with. Out of a large number of fatal cases, M. Boudin has only found six in which mutilation is noticed to have occurred; and it is a singular circumstance that in four of these the tongue was the part affected. Wounds and fractures, especially of the skull, are sometimes but rarely noticed.

The post-mortem appearances in cases of death by lightning vary extremely. The body sometimes retains the attitude in which it was when struck. Thus a case is related in which a man was killed on horseback, and the horse proceeded some distance with the dead rider still in the saddle. At other times the body is thrown to a considerable distance. The clothes are often burnt or torn, even when the surface of the body is not injured. In respect of muscular rigidity, opinions, and probably facts, vary also. John Hunter taught that "animals killed by lightning, and also by electricity, have not their muscles contracted;"‡ but this is certainly inconsistent with common experience, although it may be the fact in exceptional instances. Thus in Dr. Richardson's work on the *Coagulation of the Blood*§ may be found the account of an experiment performed on a large dog, which was killed by a powerful electric current. In half an hour rigor mortis commenced, and increased to such an extent that "in five hours the dog appeared as if frozen hard,* or carved out of wood, being quite stiff and inflexible." The same author (p. 138) makes death by electricity the only exception to the rule that in cases of immediately sudden death the blood coagulates "with moderate firmness and in the ordinary mode." To the same effect is a case reported in the *Philosophical Transactions*, vol. lxiii. p. 177, where a man was struck dead while in bed. A doctor was sent for, who, at the request of the patient's wife, opened a vein in the arm. The blood was so fluid that it continued to ooze out till the man was put in his coffin. M. Boudin, however, says, that the blood is sometimes found coagulated; and Sir C. Scudamore's experiments prove the same fact in animals killed by electricity.† The heart is usually, as it seems, flaccid and empty. The condition of the lungs seems very uncertain. Putrefaction may be sometimes hastened, but is more often retarded.

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* *Œuvres de F. Arago*, Paris, 1854, tom. i. p. 377.

† Cases are reported in which the entire bodies of men and animals have been reduced to ashes; but such events (if indeed they be not mere exaggerations) must be very rare.

‡ *Works*, by Palmer, vol. iii. p. 114.

§ Astley-Cooper Prize-Essay, p. 96.

Death is caused in immediately fatal cases by the shock to the brain and nervous system, and perhaps in some rare instances by asphyxia; and it appears impossible to express the indications for surgical treatment in these cases more clearly and succinctly than they are thus given by Sir B. Brodie: "Expose the body to a moderate warmth, so as to prevent the loss of animal heat, to which it is always liable when the functions of the brain are suspended or impaired, and inflate the lungs, so as to imitate natural respiration as nearly as possible."‡ It may be added, that these attempts to restore animation should not be too soon given up, since stories are on record (one of which has been quoted above) of the return of animation after its apparently complete suspension during more than an hour. Cold affusion, stimulating enemata, and stimulants administered by the mouth, will be appropriate adjuvants to this treatment, especially in the less severe cases. The prognosis is generally favourable, as far as the recovery of life goes, in cases not instantly fatal; and even when some of the special senses are temporarily abolished, their restoration is not hopeless.

TIMOTHY HOLMES.

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* This may account for the fact, that persons killed by lightning have sometimes been described as presenting all the appearances of having been frozen.

† Taylor's *Med. Juris.*, art. "Lightning."

‡ Op. cit. p. 104.

FRACTURES.

FRACTURE may be defined to be a sudden, violent solution of continuity of a bone.

Causes. The causes of fractures are of two kinds; predisposing, and determining. The predisposing causes, properly speaking, are those morbid conditions of the bones which render them unusually fragile. But the term is also made to include the influence of certain natural agencies, viz. the age and sex of the patient, and the liabilities of different bones.

The influence of age goes nearly hand-in-hand with the liability to exposure to the external causes. The smallest number of fractures is found in infancy, especially between the ages of four and five. At puberty, and again at the age of twenty-five, there is a sudden rise in their ratio; thence the increase is small, but gradual, up to the age of sixty, beyond which the proportion is stationary. The increase after forty must be ascribed to the changes in the bony tissue which occur at that period of life. Certain fractures may be considered the peculiar appanage of old age; as fracture of the neck of the femur, or of the lower end of the radius.

As might be expected, men are much more liable to fractures than women, except in early infancy and in extreme old age. The differences in the development and decay of the skeleton sufficiently explain these exceptions. There are also wide differences in the liabilities of different bones, depending on their form, position, functions, and structure; the long bones suffering most, especially those which are most exposed to the violence of falls.

The morbid conditions of bone which predispose to fracture are either confined to the bone itself, or are parts of a general cachexia. Of the former kind are atrophy, caries, necrosis, chronic inflammation, tumours of all kinds in the bone, and ulceration in consequence either of the pressure of an aneurism or tumour external to it, or of the spreading of an ulcer from the soft tissues.* In all these cases the fracture is to be regarded rather as a complication of the more formidable disease. The general predisposing affections mentioned by authors are scurvy, cancer, gout, syphilis, scrofula, rickets, fragilitas and mollities ossium.

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* *Trans. of Path. Soc.* vol. x. p. 234.

Scurvy does not appear in general to have any injurious effects on sound bone, though in one case Berard found the bones of the lower extremity congested and fragile.* Numerous instances have been met with of unusual fragility in cancerous subjects; but in all (with, perhaps, one only exception, mentioned by Rumpelt†), nodules of cancerous deposit have been found imbedded either on the surface or in the interior of the bone.

Gout and rheumatism have been imagined, rather than proved, to weaken the tissue of bones. Not so, however, with secondary syphilis. M. Donatus mentions the case of a syphilitic patient in whom very slight exertion produced a fracture, at one time of the right humerus, at another of the left.‡ Since that, many cases of the kind have been recorded. In two of B. Bell's patients the thigh-bones were broken by a slight force; and Brodie has seen the clavicle give way at the seat of a node.

But the disease which, more than any other, predisposes to fracture is unquestionably rickets, or its later type, fragilitas ossium. M. Guersant states, that out of a mean of eighty annual cases of fracture in early life, he has found about one-third in rickety children.§ These cases are of two classes. In some, as in most of those described by Dupuytren,‖ fracture is preceded for some days, or even weeks, by bending, and union is tardy. In others fracture occurs suddenly and repeatedly from the slightest causes. Gibson had under his observation a youth who, at the age of nineteen, had suffered twenty-four fractures, eight of which were in the clavicle.¶ Arnott gives the history of a girl who, between the ages of three and fourteen, had thirty-one fractures, all of the long bones.** Analogous cases are recorded by Tyrrell†† and Lonsdale;‡‡ and Esquirol possessed the skeleton of a woman, in which the traces of more than two hundred fractures, occurring at different periods, could be counted. In all the above cases the general health has appeared good, and union has not been retarded, nay more, it has been sometimes unusually rapid. Stanley, however, records a case in which no union could be obtained.*

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* *Dict. de Méd.* en 30 tomes, 1836, art. 'Fracture.'

† *Gaz. Médicale*, 1835, p. 641.

‡ *De Hist. Med.* lib. v. cap. 1.

§ *Clin. des Hôpitaux des Enfans*, 6ième année, p. 28.

‖ *Extrait d'un Mém. sur quelques cas particuliers de Fractures*, &c., in *Bull. de la Faculté de Méd.* 1811, p. 156.

¶ *Institutes of Surgery*, vol. i. p. 370.

** *Medical Gazette*, June 1833.

†† *St. Thomas's Hosp. Reports*, No. 1.

‡‡ *Prac. Treatise on Fractures*, 1838.

The immediate causes of fracture are of two kinds; external force, and muscular contraction. The former of these is also exerted in two ways: directly, when the fracture occurs at the part immediately subjected to violence; and indirectly (*contrecoup*), when the force applied at one point is transmitted, and causes a fracture elsewhere. Indirect force is probably the most frequent cause, pure muscular contraction the rarest. But in by far the majority of cases the latter coöperates with the more palpable cause, by directly increasing the strain upon the bones, and, still more, by fixing them. Hence the comparative facility with which partial fracture may be produced in the dead body, by direct force, and the great difficulty, or, perhaps, impossibility of effecting, experimentally, any kind of indirect fracture. Hence, too, the comparative rarity of fractures among skaters, and the proverbial impunity of drunkards.

The two most prolific causes of fracture are falls and blows. Although, as a rule, falls produce indirect fractures and blows direct, yet they are by no means uniform in their results. A fall may be, and may resemble in its effects, a series of blows, as in the case of a fall from a scaffolding. Nothing, in fact, is more apparently capricious than the effects of falls. Thus, a fall on the sole of the foot may fracture either the os calcis, the tibia in any part of its length, the patella, the femur, the pelvis, or even the cranium. The causes of such differences, as well as of the varieties in the form of fracture, are more or less traceable to the degree of violence of the fall, the position of the individual and of the limb, perhaps to the different strength of the bones in different persons, but especially to the precise muscular action called into play.

Neither is there greater uniformity in the mode of operation of these causes. Commonly it is either compression or forced flexion. But in the production of certain fractures torsion has a large share; as in fracture of the fibula and of the ribs, and in fractures of diseased bones during such slight efforts as turning in bed. Even traction assists the other causes in such cases as fracture of the patella, and separation of epiphyses.

The few recorded instances of fracture of the long bones by unaided muscular action can be ascribed solely to violent and sudden flexion. In different cases, the humerus, the bones of the forearm, the femur, clavicle, even the tibia, have yielded during a powerful muscular effort.* It is a generally received opinion, however, that no long bone can be broken in its shaft by the mere contraction of its muscles unless impaired by some morbid change in its structure: an opinion confirmed by the observation of Nicod,† that in most of these cases fracture has been preceded by pains in the broken limbs, and in some instances followed by actual evidences of disease, as abscess or exfoliation. But abnormal increase of the muscular power, as during convulsions, may be sufficient to account for it. The bones commonly fractured by muscular action are the patella, os calcis, and olecranon. The ribs, and even the sternum,‡ have been known to be broken by the violent action of the diaphragm during coughing, but in all probability they were weakened by partial absorption or atrophy.

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* *On Dis. of the Bones*, 1849, p. 241.

The cause of a fracture has considerable influence over its subsequent course and results. It is manifest that, as a rule, the consequences of direct are likely to be far more serious than those of indirect force. For not only are the effects on the bone itself more severe, but the soft parts covering the fracture are subjected to the crushing power of the external violence, in addition to those accidents to which they are equally exposed in both classes of fractures from the displaced fragments.

The causes of intra-uterine fractures have created much discussion, and are still undecided. These fractures have been found in all conditions; simple and compound, single and multiple, ununited and reunited. In the majority of cases they are associated with manifest deformity of some part of the body. As many as twelve, forty-three, and 112 fractures§ have been found in the same fœtus, depending, of course, on imperfect development of the bones, or congenital rickets. In a few the fœtus has been otherwise perfect, and the fractures have appeared to be due to external violence;‖ though it is doubtful how far this explanation can be admitted, so long as the membranes remain entire. Their more general origin is probably abnormal muscular contraction, either sudden or continued; and to this Mr. Brodhurst ascribes even the fractures of sound bones.*

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* For a summary of such cases see Cooper's *Surg. Dict.*, art. 'Fracture;' and Hamilton on *Fractures and Dislocations*, 1860.

† *Annuaire Méd.-Chir. des Hôp. de Paris*, 1819, p. 494.

‡ *Gaz. des Hôpitaux*, Mars 1830.

§ Chaussier, in *Bull. de la Fac. de Méd.*, 1813, p. 301.

‖ Rodrigues, *Amer. Jour. Med. Sci.* Jan. 1854.

Varieties. Fractures are divided primarily into simple and compound; the essential character of the latter being the coexistence of a wound in the skin, with which the fracture communicates. This distinction is important; the two great classes of fractures differing from one another in the nature of the process necessary for their repair, and, consequently, in their results and dangers, and the duration of their treatment. There are two ways in which the wound may be produced at the time of the accident; from without, by the same direct force which fractures the bone; or from within, by the end of one or both fragments being thrust through the soft parts, whether by the continuance of the original force, or by the weight of the body. The latter mode is the more frequent of the two; and it is mainly owing to this that compound fractures are more common in the leg than in any other part of the body. The difference between the two modes of production is essential, and must in all cases be noted. For while the former implies greater or less contusion, necessarily followed by inflammation, often by excessive suppuration and sloughing; the latter may be attended by so little injury, as to admit of primary union of the wound, and conversion of the fracture from compound to simple. There are also two ways in which a fracture may become compound at any subsequent period; ulceration of the skin from pressure of a displaced fragment, which most commonly occurs in very oblique fractures of the tibia; and the formation and bursting of an abscess. This accident, the conversion, viz. of a simple into a compound fracture, is most to be feared about the second or third day; but, of course, it may occur later.

Besides this primary division, fractures may be conveniently classed under four heads. I. Simple, single fractures. II. Multiple fractures. III. Incomplete fractures. And IV. Fractures with complications.

I. Of simple, single fractures there are two kinds; fracture proper, and separation of epiphyses. Of fracture proper there are also three varieties, named from its direction; transverse, oblique, and irregular or dentated.

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* *Memoir read before the Med.-Chir. Soc.* See *Lancet*, April 7, 1860, p. 348, for a full discussion of this matter; also Malgaigne's work, p. 30. See too, for a further consideration of the subject, the essay on SURGERY OF CHILDHOOD, below.

Transverse fracture is not met with in the shafts of long bones, though enumerated by most writers. Cruveilhier* considers it impossible. Camper† was not able to meet with a single specimen of the kind in the museums of Germany, England, or Holland. Neither do those of Paris contain one, according to Malgaigne, who also failed in his attempts to produce this kind of fracture in the dead body. Hence it may fairly be concluded that it has never yet been observed. Nevertheless, a fracture may be partly transverse and partly oblique. Transverse fractures occur in irregular and short bones, such as the scapula, lower jaw, patella, and vertebræ; and in the spongy extremities of long bones, as the olecranon and the lower end of the radius; but even in these there is commonly more or less of obliquity.

The great bulk of fractures of the extremities are oblique. The direction of the obliquity may be antero-posterior or transverse, and its degrees are endless; very oblique fractures being often improperly called longitudinal. Of late years French writers have called special notice to an important variety of oblique fractures occurring only in the shafts of long bones, and of special frequency in the tibia. The upper fragment is prolonged into a sharp point, like the point of a pen, the lower presenting a corresponding deficiency. Fractures of this kind are called spiroid by M. Gerdy, and by others cuneate, V-shaped, or wedge-shaped.‡ The point of the upper fragment, driven forcibly against the lower, frequently fissures it longitudinally. These fractures are represented by M. Gosselin as peculiarly dangerous, both on account of the great extent of medullary tissue laid bare, and the crushing to which it is subjected. Their danger, however, is exaggerated.

In dentated fractures the surfaces are studded with irregularities, more or less pointed, and interlocking so as to present obstacles to the displacement of the fragments, or to their reduction when displaced. In such cases the fragments may remain in position, the only perceptible displacement being an alteration in their relative axes, or a bending of the bone. One or more of these points may be broken off, a circumstance which materially affects the nature of the fracture, and the mobility of the fragments. A large proportion of oblique fractures are dentate.

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* *Traité d'Anat. Path. gén.*, 1849, t. i. p. 86.

† *Obs. circa Callum*, in *Essays and Obs. Phys. and Lit. of Soc. of Ed.*, 1771, vol. iii. p. 537.

‡ And by the French, 'fractures en bec de plume.' See Bourcy's *Thèse Inaug.*, Paris, 1855; and a memoir by M. Gosselin, in *Mém. de la Soc. de Chirurgie*, 1858, t. v. p. 147.

Separation of epiphyses, commonly confounded with simple fractures, or congenital defects, scarcely attracted notice till Bertrandi* and Monteggia,† and subsequently Rognetta,‡ drew attention to its peculiarities. Although it has been demonstrated, by post-mortem examination, only at both ends of the humerus, femur, tibia, and fibula, and the lower end of the radius, yet it has been diagnosed during life in other parts of the body. The olecranon may separate. Leveillé§ cites a case of separation of the condyles of the occiput. Rognetta ranks under this head all the recorded cases of supposed fracture of the odontoid process; separation of the three portions of the os innominatum in the cotyloid cavity; separation of the costal cartilages from the ribs or sternum, and of the portions of the latter bone from each other. The epiphyses which enter into the formation of the ginglymoid joints unite with the shaft of their bone sooner than those which correspond to the enarthrodial; therefore separation of the latter is the more frequent. Rognetta also points out that the mode of connexion of an epiphysis affects the facility of its separation; some, as the head of the humerus, femur, or tibia, being distinct masses of bone, retained mainly by the periosteum; others, as the lower end of the tibia, and both ends of the radius and ulna, being rather ossifying extremities of the bone, connected and strengthened chiefly by the ligaments of the joint, and therefore less liable to be rent apart. The epiphyses of insertion, as the trochanters, ossifying as they do from their bases, rarely separate.

Separation of epiphyses is necessarily an accident of early life, usually before the age of sixteen. In some persons, however, in whom complete ossification is deferred, it may occur at a later period.‖ According to M. Gueretin, whose observation has been confirmed by others, it is generally accompanied, when it occurs after the age of two, by splintering of the shaft of the bone.¶ It may happen during intra-uterine life from blows received by the mother.* It has been not unfrequently produced during birth by violent attempts at delivery. After birth it is caused either by direct or indirect force; by falls, blows, or forcible traction, as commonly practised in dragging children by the arms.

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* Bertrandi, *Opere Anat. e Chirurgiche*, t. v., Torino, 1787.

† Monteggia, *Inst. Chirurg.* t. iv., Milano, 1814.

‡ *Mémoire sur la Divulsion traumatique des Epiphyses*, par M. Rognetta, in *Gaz. Médicale de Paris*, 1834, t. ii. pp. 433 et seq.

§ Rognetta, loc. cit.

‖ For statistics of its frequency see M. Salmon's papers in the *Clinique des Hôpitaux des Enfans.*

¶ *Presse Médicale*, 1834.

II. Of multiple fractures there are four varieties. 1st. Two or more fractures of the same bone. 2d. Separate fractures of different bones. 3d. Splintered; and 4th, Comminuted fractures.

1st. Double fractures in the shafts of bones are rare, because they can only be produced, either by the simultaneous action of two separate forces, or (which is virtually the same thing) by the action of a single force over a large surface. For the same reason, they are generally attended with great damage to the soft parts, and proportionate danger. But in the articular extremities of certain bones, as the humerus and femur, they are not unfrequent, owing to the peculiar shape of their condyles, between which any transmitted force is divided. Such fractures of course extend into the neighbouring joint.

2d. Fractures of two or more bones are naturally separable into two groups. One of these includes the numerous cases of fracture of contiguous or parallel bones, as the ribs, the two bones of the leg or forearm, the metacarpal or metatarsal bones. The other group comprises fractures of two or more bones in separate parts of the skeleton. These are comparatively rare, being not more than 1·3 per cent of all fractures. The leg, the thigh, the arm, and the cranium are the parts most frequently involved. In about one-fifth of the cases there are three separate fractures. More than three are rarely found. The cause of these fractures is almost invariably a fall from a height. As might be expected, they are more fatal than any other class. Produced by great and extensive violence, they are attended with excessive shock, and for the most part with internal injuries. When not so complicated, their danger is in proportion to the number of fractures. Few, indeed, of their victims recover. But, if the early dangers are securely past, each separate fracture is attended with less risk of local accidents, as inflammation and its consequences, and meets with fewer obstacles to its union than if it were single. For this curious observation we are indebted to Dupuytren.

3d and 4th. Splintered and comminuted fractures differ from one another principally in degree. A splinter is any pointed fragment, not involving the whole thickness of the bone, except in the case of a flat bone. In comminuted fractures the bone or bones are either separated into innumerable fragments, which are isolated and scattered among the surrounding tissues; or they are crushed, and, as it were, compressed, the bony tissue appearing to occupy less space than originally, as though there were actual loss of substance. This latter form of fracture is seen only in spongy bones, as the vertebræ, os calcis, and articular ends of long bones. A variety of it—impacted fracture—of common occurrence in certain localities, as the neck and lower end of the femur and lower end of the radius, differs from it by its capability of repair without loss of tissue or deformity.

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* Carus, in *Arch. Gén. de Méd.* t. xvi. p. 288.

III. There are four species of incomplete fracture: 1st. Fissures. 2d. Proper incomplete fracture, or bending of bones. 3d. Separation of a splinter. 4th. Perforations.

1st. Fissures are most commonly met with in the cranium. In other flat bones, except the ribs, they are rare. There are records, however, of their occurrence in the lower jaw, and in the os innominatum. In the short bones they are still more rare. In the shafts of long bones they occur under two conditions. In some cases a fissure, commencing at the articular extremity of a bone, as between the condyles of the femur or humerus, is prolonged to a certain extent into the shaft. It then involves the whole thickness of the bone, and there is usually a distinct separation of its lips. In other cases the fissure does not at any point reach the margin of the bone. The possibility of such fissures has been denied by many surgeons, except as radiations from the wounds inflicted by firearms (*starred* fractures). Nevertheless, Duverney,[*] so long ago as 1751, detailed two well-marked cases in the tibia; two others, in the same bone, are recorded by Campaignac[†] and Becane;[‡] and Malgaigne depicts a long fissure in the femur, from a specimen in the Museum of the Val de Grace.[§] These fissures vary much in depth; some do not even reach the medullary canal; they never traverse the whole thickness of the bone; and, of course, there is no separation of their borders.

2d. Incomplete fractures, properly so called, occur both in the flat and long bones. Permanent depressions of the cranium produced during birth are usually, and according to some authorities always, accompanied by slight fracture. So, too, in the bones of the adult cranium fracture may be confined to either table, or to the diploë. Partial fracture of the ribs occurs at all ages; and Adams drew attention to its frequency in the neck of the femur.* The vertebræ bend up to a later period of life than other bones, because they contain more animal matter.†

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[*] *Traité des Maladies des Os*, 1751, tom. i. cap. iv.

[†] *Des Frac. i. complètes, &c., Jour. Hebdom. de Médecine*, t. iv. 1829, p. 97.

[‡] *Abrégé des Maladies qui attaquent la substance des Os*, Toulouse, 1775, p. 134.

[§] *Traité des Fractures et des Luxations*, 1847, plates.

Bending, or incomplete fracture, of the shafts of long bones is by no means rare in childhood, especially between the ages of five and fifteen. Hart‡ saw five cases in three years; Jurine,§ at least twenty in forty years; and Hamilton|| has seen more. It has been observed in all the long bones, but most frequently in the forearm. Next in order of frequency come the clavicle (in which Hamilton saw it fifteen times, and Blandin¶ five times), the femur, and tibia. In the bones of the forearm singly, in the humerus and fibula, it is rare. It may be doubted whether simple bending without fracture ever occurs in the human subject; it has only been seen as the result of experiment in the fibula of young animals, accompanied by complete fracture of the tibia.** It appears certain that a bone simply bent will immediately resume its form, unless supported by the fracture or displacement of a neighbouring bone. In all cases the fibres on the convexity of the curve give way, and even a bone so broken may resume its proper form. With few exceptions, a bent bone recovers its shape after a few weeks, or perhaps months, by its own elasticity, aided by compression. The possibility of partial fracture in the adult has been called in question by many. Jurine, however, distinctly affirms that he has seen such cases; and that it may be readily produced on adult bones in the dead subject, is proved by the experiments of Meding,†† Campaignac, and Malgaigne.

3d. The separation of a splinter, leaving the remainder of the bone intact, is a rare accident. It can only be effected by a

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* *Dublin Jour. of Med. and Chem. Science*, vol. vi. 1835, pp. 220 et seq.

† *Lettsomian Lect. on the Phys. Const., Diseases, and Fractures of Bones*, by John Bishop, 1855. This author assigns teething, and the quantity of phosphate of lime which that process requires, as one principal cause of the softness of the bones up to the age of four.

‡ *Dublin Jour. of Med. and Chem. Sci.*, No. 1. p. 1.

§ *Jour. de Corvisart et Boyer*, t. xx. p. 278.

|| *Treatise on Fractures*, &c. 1860, p. 81.

¶ *Jour. de Méd. et de Chir. Prat.*, July 1842.

** For remarks on the mode of production of partial fractures, see Campaignac's article, supra cit.

†† *De Regeneratione Ossium per experimenta illust., Diss. Inaug.*, Lips. 1823.

wounding instrument, as a sabre or ball; hence it is necessarily compound. The cranium and prominent points of bone are most exposed to this peculiar form of injury. Rarely, indeed, are the shafts of long bones so fractured.

4th. Perforations, also, are necessarily connected with an external wound. All bones are liable to this form of fracture, which is attended by this peculiarity, that the body which inflicts the injury may remain in the bone, the perforation being complete or incomplete.

IV. The complications of fractures comprise all concomitant injuries to organs other than the bones themselves, and all general affections. Only one distinct variety is included under this head; viz. fractures which extend into a joint. These, unless produced by a ball or penetrating instrument, are usually simple.

Diagnostic symptoms. The symptoms of fracture are rational and sensual. The rational symptoms are the evidences of injury to internal viscera, resulting from the fracture of the bones which enclose any of the large cavities. As evidences of fracture they are rarely of much value, except in those cases where their gravity indicates that the fracture itself is of secondary importance to the internal complication. The sensual symptoms are of two kinds: certain, pathognomonic, or unequivocal; and uncertain, or equivocal. The unequivocal signs are four: the sharp crack heard by the patient at the moment of fracture, unnatural mobility of the fragments, deformity, and crepitation. The equivocal symptoms are three: pain, swelling, and loss of power.

In the great majority of cases the attention of the patient is distracted by so many circumstances at the moment of fracture, by the sudden pain, by alarm, and by surrounding noise, that he is not conscious of the slight crack produced by the snapping of the bone. It is generally, however, heard unmistakably in cases of fracture, at least of long bones, by muscular contraction; or when the accident happens in a quiet place, as in bed, or during the efforts to reduce a dislocation. It is, when heard, a valuable sign; the only thing with which it would be possible to confound it being the sudden snap of a tendon, or perhaps that of the displacement or rupture of a ligament during dislocation.

Mobility of the fragments is, of course, a necessary condition both of deformity and crepitation. But it is frequently diagnostic without the latter accompaniment, as in fracture of deep-seated bones, or when there is separation of the fragments. The most readily detected and most conclusive test of fracture of the fibula is, mobility of the lower fragment without the upper. It frequently occurs, however, that this symptom is either absent, or not sufficiently decided for the purpose of diagnosis. In many fractures of short and flat bones, as of the spine or pelvis, and in comminuted fractures, it can scarcely be said to exist. The same is the case with some fractures of a single bone, supported by a neighbour, where one acts as a splint to the other; and in dentated and impacted fractures. And in all fractures in the neighbourhood of joints its interpretation is interfered with by two causes; the difficulty of holding the smaller fragment, and the natural mobility of the joint. Lastly, it is a test not to be relied on as applicable to the ribs, on account of their elasticity.

Of all the symptoms of fracture, deformity is the most valuable, because it is the one which gives the greatest amount of information. It is not, of course, present in every case, being often prevented by the shape or connexions of the bone broken; as in fracture of the broad upper end of the tibia, or ulna; of one of two parallel bones; of the sternum; of the face, or cranium.

There are five varieties of displacement, having reference, 1st, to the diameter of the bone, *transverse* or *lateral;* 2d, to its length, *shortening* or *riding;* 3d, to its axis, *angular* displacement; 4th, to its circumference, *rotation;* and 5th, to the contiguity of the fragments, *direct separation.*

Transverse displacement may take place in any direction, though fractures of the same bone preserve, for the most part, a certain degree of uniformity in this respect. Its amount is equally variable. In oblique fractures it is more or less inevitable. When complete, it is necessarily accompanied by shortening, unless this be prevented by the support of a neighbouring bone. In fractures of superficial bones it is readily both seen and felt; and in very oblique fractures, especially of the tibia, the projecting fragment threatens to, and in some instances actually does, pierce the integuments. In more deeply seated fractures it may be ascertained, though not so readily, by tracing the bone with the fingers, and by noting the increase in the diameter of the limb at the seat of fracture. Longitudinal displacement is present to a greater or less extent in all oblique fractures. In all cases it is the inferior fragment which is displaced. Although, as a rule, it implies the addition of transverse displacement, this is not the case in impacted fractures. In them the lower fragment is generally driven into the upper; but the reverse occasionally happens in the neck of the femur. In most, if not in all of these cases, there is more or less angular displacement, a species of deformity rarely absent from the fractures of long bones, being readily produced by the mere weight of the limb, and which, when distinctly marked, is in itself sufficient evidence of the nature of the injury. Rotatory displacement is also effected by the movement of the lower fragment. It is especially characteristic of fractures of the femur, though not confined to them; and is recognised by comparing the positions of the processes of the broken bone with their natural relations. Displacement by separation takes place in nearly all (transverse) fractures of the patella, olecranon, and os calcis, in all of which it is produced by muscular contraction. It is rarely seen elsewhere; but in some fractures of the lower end of the fibula, the lower fragment may be drawn away from the upper by rotation of the foot; and in severe fractures of the skull there may be an interval between the fragments, or between two bones separated at a suture.

The causes of these various kinds of displacement are four: the continued action of the violence which caused the fracture; the weight of the limb, or of the body; the subsequent action of other external forces; and, lastly and principally, the influence of the muscles. The original violence may produce any of its varieties, with few exceptions. It is the sole cause of impaction, and the chief agent of angular displacement. Most indirect fractures of the lower extremity, and those of the upper which are caused by falls on the hand, suffer from the weight of the body. This, indeed, it is which renders many indirect fractures compound. Angular and rotatory displacement are, to a great extent, caused by the weight of the limb. It is not often that any subsequent violence is brought to bear on the position of the fragments, except through the imprudence of those who carry the patient, or of himself during delirium. The most powerful and most unfailing cause of displacement is muscular action. This is twofold: healthy, tonic contraction, and spasmodic. The influence of the former is usually heightened by semi-voluntary movements of the patient, provoked by the efforts at reduction. Although muscular contraction has a large share in the production of all the forms of displacement, it is the special agent of shortening. The muscles connected with the lower fragment are answerable for this result, so that in the great majority of cases it is this fragment which suffers displacement, and is to be brought into contact with the upper; the apparent rising of the latter being due solely to the displacement of the former. But in fractures near to the upper end of a bone, transverse displacement may be effected by the muscles attached to the upper fragment, as happens in fracture of the femur immediately below the trochanters, and of the neck of the humerus. In children the fragments usually undergo less displacement than in adults; partly because, on account of the elasticity of their bones, their fractures are more irregular; but principally because the periosteum is often not completely torn across, and the patients are much less exposed to the after causes of displacement.

In examining for displacement, the only sources of fallacy are the remains of some former injury, which must be learnt by inquiry, and the presence of splinters, or of effused blood; which last may mask, or simulate, a bony ridge. The sensation imparted by coagulated blood has more than once led to error in the examination of the cranium for fracture; and a similar condition is occasionally met with over other superficial bones.

Crepitation may be recognised in most cases of fracture, and is a symptom which cannot mislead. In splintered and comminuted fractures, and when the fragments are loose, the least motion or pressure suffices to determine it. Generally, however, some care and art is requisite for the purpose; the lower fragment being moved while the upper is fixed by a firm grasp, or both fragments being simultaneously moved in opposite directions. In doubtful cases, or where the limb is large, the examination is facilitated by confiding the upper fragment to an assistant, and exploring the supposed seat of fracture with the fingers during the above movements. In certain fractures in the neighbourhood of joints, as the hip or shoulder, rotation of the limb, or flexion and extension, answer the purpose better than lateral movements. If there is any interlocking of the fragments, they must be separated by extension before they can move upon each other. In partial fractures no crepitation can be produced till the bone is straightened, and the broken surfaces brought into contact with each other, and not always then. In many fractures of the ribs, the necessary movements can only be effected by making the patient cough. To facilitate the discovery of crepitation in obscure cases, M. Lisfranc* advocates the use of the stethoscope, which may be occasionally resorted to with advantage in the examination of fractures of the ribs, pelvis, or shoulder, or when there is excessive swelling. But in most cases it is unnecessary and cumbersome.

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* *Mém. sur de nouvelles Applications du Stéthoscope*, par M. J. Lisfranc. Paris, 1824.

In many instances this symptom is altogether wanting: in all impacted, and many dentated fractures; when the fragments are separated, as in fracture of the patella; when they ride (in which case it can only be obtained after elongation); also in some fractures of a single bone in limbs provided with two, when its neighbour prevents the necessary movements; or when a clot of blood or bit of muscle intervenes between the fragments.

A sound more or less resembling crepitation may be caused by emphysema; by the rubbing of tendons in their sheaths, or of the inflamed and roughened surfaces of a joint, aided, according to Sir A. Cooper, by the altered state of the synovia. This sound, as compared with crepitation, is slight, dull, and creaking, and may be produced by simple pressure of the joint; and the rubbing of tendons is analogous to it, and jerking. In the discrimination of these sounds the stethoscope has its chief use.

The remaining symptoms, pain, swelling, and loss of power, being common to other forms of injury, are of little or no value for the purpose of diagnosis, except as indicating the precise seat of fracture, or, in some instances, the nature of its cause, whether direct or indirect. However, if no large vessel is torn, the amount of ecchymosis is a good general guide to the extent of the mischief, both to the bone and soft parts. In doubtful fractures, too, pain may acquire importance by its persistence, or even increase, long after the subsidence of ecchymosis and inflammatory swelling, especially if accompanied by acute though circumscribed tenderness.

There are two forms of injury which may be mistaken for fracture,—a severe bruise, and dislocation. In some instances of the former it is not possible to obtain conclusive evidence of the nature of the case till after the subsidence of the swelling. There is seldom much difficulty, however, in distinguishing dislocation from a fracture near the joint. In the former the natural movements of the joint are impeded, and the bones are more or less fixed in their new position; they offer considerable resistance to reduction, but, when reduced, remain so. In fracture, besides the crepitus, when it exists, there is preternatural mobility, and the length and shape of the limb may be readily restored by extension, but only so long as this extension lasts. In the fractures near superficial joints, as the elbow or wrist, a careful examination of the relations of the most prominent processes precludes the possibility of error.

Besides the above general symptoms, variously combined in different cases, there are others peculiar to certain forms of fracture.

Of course in compound fractures there is little room for uncertainty, because the nature and extent of the injury is exposed to the view and touch. When a compound fracture extends into a joint, there is commonly an escape of synovial fluid. Care must be taken not to mistake for this the yellow drops of fat which ooze from the subcutaneous tissue, especially in the neighbourhood of the knee: it is recognised by the colour, synovia being white. At a later period these fractures are accompanied by the symptoms of inflammation of the joint itself.

Two only of the varieties of fracture, from certain peculiarities in their history and symptoms, require especial notice,—incomplete fractures and fissures. In cases of incomplete fracture in children, the limb is distinctly bent, and offers considerable resistance to reduction. There is little or no absolute shortening; indeed the convex side is lengthened. When the bone is straightened, or nearly so, slight crepitus may sometimes, but not always, be distinguished during rotation. In two or three days, but not before, a slight swelling may appear at the part, and about that time the bone sometimes gives way altogether from subsequent violence. The child always evinces pain, and unwillingness to use the limb. The history of violence, generally a fall, and the age of the patient, assist the diagnosis. Occasionally, but not often, a slight transverse fissure can be felt through the skin.

It is very rarely that a simple fissure of a bone can be recognised at first. If it extends into a joint, there may be slight lateral movements of the fragments on one another; and the subsequent inflammation of the joint, especially if severe and obstinate, will justify suspicion. But in the rare case of fissure confined to the shaft of the bone there can be no definite indication of its nature. It may well be that some fissures of this kind unite kindly, but in such a case the diagnosis can be no more than conjecture, founded upon the history and the long continuance of fixed pain and tenderness. More commonly the periosteum, and perhaps the medullary membrane, have suffered too severely to permit so simple a termination. The usual course and the danger of these cases is best illustrated by an example from Duverney.* A man received a kick from a horse on the centre of the left tibia. This was followed by severe pain and sloughing of the skin, which, however, readily healed, and the patient went about as cured. Three months later he was again confined to bed by the accession of sudden, acute pain. After much ineffectual treatment by emollients, the bone was exposed, and a long deep fissure was found, the edges of which were raised twice, giving exit, on the second occasion, to pus. Subsequently the bone was trephined, and an abscess laid bare in the medullary cavity. That a fissure of a bone may occasion abscess long after the infliction of the injury (perhaps even, as Wurtzius maintains, after many years), is proved by a statement of Campaignac, that he possessed a tibia in which a complete fracture had united; but a fissure produced at the same time had made no effort towards repair.

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* Op. cit.

Treatment. Immediately after the accident there are certain minor much-neglected precautions to be taken, the observance of which materially affects the comfort and well-being of the patient. Many fractures of the lower extremities are seriously aggravated by his own impatient movements, or by the ignorance and thoughtlessness of attendants. Frequently is a simple converted into a compound fracture, the soft parts are bruised and lacerated, and the foundation laid for violent inflammation and spasms. By small care such accidents may readily be avoided. The patient should be placed on a horizontal support, whether a door or shutter, or a proper litter, and the foot of the injured limb should be tied to the other to prevent its eversion by its own weight. Conveyance in a carriage of any kind is to be condemned. Wherever the nature of an employment engenders many accidents of this kind, special apparatus should be provided. In military practice, litters are indispensable; and M. Vallat contrived an ingenious kind of box to be used in mines, where, from the narrowness of the shaft, it is impossible to preserve the horizontal position. Wathen, too, invented an instrument to fix and extend the fragments during conveyance;* but the utility of such instruments is, of course, limited.

No examination of the fracture should ever be made till the patient occupies that position in which he is intended to remain during the treatment. All voluntary movements on his part must be discouraged during the undressing and subsequent examination. In a very few cases, especially in children, and when there is excessive pain and ecchymosis, it will be found advisable, or even necessary, to place the patient under the influence of chloroform before a proper examination can be made, or reduction effected.

The treatment presents three indications: reduction of the fragments to their normal position; their maintenance in this position till consolidation is effected; and the counteraction of unfavourable constitutional symptoms and complications.

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* *The Conductor*, &c., by J. Wathen, 2d ed. Lond. 1767.

If there is no displacement, or if, by reason of ecchymosis, or of the depth of the fracture, it cannot be ascertained; or if, although distinctly recognised, it cannot be removed, as in fracture of the spine, any attempt at interference would of course be absurd. The means of reduction necessarily vary with the nature of the displacement. For angular or rotatory displacement, or simple separation, they are sufficiently obvious. But the rectification of shortening by extension presents greater difficulties. It may be made either by the hand or by the assistance of apparatus. French writers speak of the common use of lacs and pulleys for this purpose; but there are serious objections to their employment. The force used in effecting reduction should not greatly, if at all, exceed that which can be permanently maintained: and if the present obstacles to that operation refuse to yield to milder methods, it is better to defer it than to run the risk of aggravating the existing injury by violence.

During extension the upper fragment must be fixed (*counter-extension*) either by the operator himself or by the hands of assistants, care being taken to exert equal force in each direction. For the application of extension, whether during reduction or permanently, Boyer lays down five rules, of which at least four are essential to success: 1st, To avoid compressing the muscles which pass over the fracture, such compression being calculated to irritate them, and excite them to increased resistance. This rule is not always regarded, and is the least important; it was, however, one of the objections to some old forms of thigh-splints, that they confined the entire muscles of the limb. 2d, To distribute over as large a surface as possible the extending and counter-extending forces. The parts to which these forces are to be applied vary in different cases. The old practice, under Petit's authority, was to grasp the fragments themselves. Boyer, Desault, and others, however, thought that not only would the muscular resistance be diminished, but greater power of extension would be obtained by applying the forces to the contiguous parts of the limb. But, in truth, neither doctrine can be exclusively adhered to. In most cases convenience is the best guide. The grasp must be laid upon that part of the limb which offers the most secure and most effective hold, such as the condyles of the humerus in fracture of that bone, and the foot in fracture of the femur. Except on this principle, no increase of power is, or can be, gained by applying it at a distance from the fractured bone. 3d, To make the extension in the direction of the natural axis of the bone. 4th, To practise it slowly and gradually, avoiding all jerks and sudden violence, which not only increase the spasmodic resistance of the muscles, but may even lacerate both them and other soft tissues. 5th, To protect from undue pressure all parts on which the forces act, and to equalise the compression of the various parts of the apparatus employed.

As soon as sufficient extension has been made, the ends of the bone are to be placed as nearly as possible in their natural relations (*coaptation* or *setting*). This is effected by bringing the lower fragment to the axis of the upper, which remains fixed. In the fractures of subcutaneous bones it is generally easy to see when the extension is sufficient, and coaptation perfect. Not so, however, when the fracture is concealed by extravasation or a thick mass of muscle. Sometimes, indeed, the sudden restoration of the outward form of the limb is a sufficient guarantee of the mutual adaptation of the fragments. Failing this guide, recourse must be had to measurement, the opposite limb being taken as the standard of comparison. Should there be any deformity of the opposite side, resulting from a previous mishap, advantage may be taken of the present accident to equalise the two extremities.

But when extension is complete, it does not always follow that coaptation is easy. The sources of difficulty are three: irregularity of the fracture; the presence of splinters; and the interposition of soft parts. In the case of a dentate or impacted fracture, it is necessary to extend the limb beyond its natural length, and then, by variously-directed manœuvres, to coax the fragments into each other. Partial rotation will sometimes effect the object. But if the displacement resist all reasonable efforts, it is better to suffer the deformity to remain (unless it is excessive, or is likely to interfere with the performance of the functions of the limb), than to run the risk of producing serious mischief by violence. The same may be said of those cases in which reduction is prevented by the peculiar position of a splinter, in which much manipulation would be highly dangerous. Even if the splinter is superficial, unless it is so prominent as to render its ulceration through the skin a matter of certainty, it should be left alone. Only in the latter case is it justifiable to extract it. When any soft parts intervene between the fragments, they are generally released by the means indicated above. If they are not, M. Laugier has proposed to divide them by subcutaneous incision.* In the one case of fractured femur, however, in which he tried it, he not only failed to effect reduction, but he created an abscess, which occasioned the death of the patient. It is far better to trust to the probability of the absorption of the intervening tissue by the pressure of the fragments.

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* *Bull. Chirurg.* part ii. p. 253.

As a general rule, reduction is to be effected immediately after the accident. Some surgeons, it is true, recommend that it be delayed for three or four, or even ten or twelve days,* till all fear of inflammation be past. No reparative process being yet commenced, the position during that period does not affect the final result; and the difficulties of reduction are, according to them, scarcely, if at all, increased by the delay. Nevertheless, immediate reduction has great advantages. It restores the patient to comparative comfort, and diminishes the chances of spasms and other evils resulting from the mal-position of the parts. Moreover, it is not true that reduction at a later period is equally easy. Not only are the fragments more or less fixed by surrounding effusion, but the muscles, accustomed to a new position, offer greater resistance to a change. There are, however, two classes of cases in which immediate reduction is either impracticable or inadvisable. If there has been from the first excessive ecchymosis, or if when the patient is first seen much inflammation has already supervened, the attempt may be not only unbearable, but highly injurious, causing laceration of the soft parts, spasms, convulsions, or even tetanus. The inflammation must be combated by the ordinary means, and reduction deferred till it is fully subdued. Still more serious is the obstacle presented, in the other class of cases, by excessive spasm. Spasm is a very constant accompaniment of fracture, especially if in the neighbourhood of a joint; so constant, indeed, as to be considered, in doubtful cases, almost diagnostic. Its degrees are variable, from the slight nocturnal twitchings, ceasing after the second or third day, to uncontrollable oft-recurring contractions, accompanied, it may be, by general convulsions. The severer form of continued spasm is far less frequent than the intermittent. The causes of spasm are three: the irritation of the fragments, injury to nerves, and the altered position of the muscles themselves, whether increasing or diminishing their habitual tension. If they are much bruised, the spasm may be less severe at first than at a later period, after they have recovered their functions. The defeat of spasm by violence is hopeless. Laceration of the muscles, or even of the vessels, will be the only result. Boyer induced fatal hæmorrhage by violent and abortive efforts to reduce a fracture of the femur.* In other cases such efforts have led to convulsions or tetanus.† Still more hopeless will be the attempt if inflammation is superadded. The two main remedies to be relied on are position and energetic antiphlogistic treatment. For pure and simple spasm full doses of opium are of great service; but if it is combined with inflammation, they only tend to mask without abating the evil. The same may be said of the inhalation of chloroform, but it is necessary to give it repeatedly in small quantities, so as to sustain its narcotising influence; for, in severe cases, the spasms will return, whenever its effects pass off, for many days. The limb should be placed in the position of semiflexion, relaxing the muscles to the utmost. But when all these means fail, recourse may be had to subcutaneous division of the opposing muscles, an operation which has hitherto been practised only in the lower extremity. (See INJURIES OF THE LOWER EXTREMITY.)

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* Sir S. Hammick recommends a fractured femur to be left till the tenth or twelfth day.

In the reduction of incomplete fractures considerable difficulty may be experienced. Immediate complete reduction is, indeed, out of the question. Usually, however, the curve yields partially, to be entirely removed only after many days, or weeks, by the pressure of splints. But if from irregularities of the broken surfaces even this partial yielding cannot be obtained, and the mal-position interferes materially with the functions of the limb (such as pronation and supination in curvature of the forearm), the fracture must be rendered complete in order that it may be reduced.

After reduction is effected, the whole treatment is directed towards obviating the influence of those causes which tend to reproduce displacement. Those causes are three: 1st, the weight of body, the limb, and its coverings. 2d, the action of the muscles. 3d, the movements of the patient. They are to be obviated by position and apparatus. But whatever be the position adopted or the apparatus employed, it is essential that the basis of support for both the body and limb be firm, unyielding, and equable. Accordingly, for fractures of the lower extremity, soft beds are inadmissible. The best is a horse-hair mattress, resting on a wooden frame, or on a board extending from the hips downwards. It is also essential, whatever kind of apparatus be used, that every part of the limb be equally supported, otherwise its own weight will reproduce displacement. The apparatus must be adapted, by its own shape, or by the use of pads, to the inequalities of the limb. All pressure on prominent points must be avoided.

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* *Gaz. des Hôpitaux*, 1844, p. 535.

† Malgaigne, op. cit. pp. 198, 284.

Formerly it was the custom to apply some kind of cerate immediately to the fractured limb. It was supposed to increase the support afforded by the bandages and splints; to repel inflammation; and, as a local sedative, to diminish pain. The practice, however, has been long discontinued. Not only was it altogether useless, but the fat checked and retained the natural secretion of the skin, and becoming rancid, was a frequent cause of pruritus and eruptions.

The apparatus for retention is very various. It includes, 1. bandages; 2. splints; 3. junks; 4. numerous forms of hyponarthecic apparatus; 5. apparatus for maintaining the flexed position; 6. suspensory apparatus; 7. special means of maintaining permanent extension; 8. immovable apparatus.*

In fracture of the extremities, various advantages have been assigned to the use of circular bandages beneath the splints, *i. e.* immediately to the limb. They have been supposed to contribute to the support of the fragments; to diminish œdema, and promote absorption of effusions; and to abate the irritability of the muscles by the equable compression of all parts of the limb. For support, however, they are altogether superfluous; their influence on spasms is questionable; their pressure is often unbearable and injurious, and they remove from view the seat of fracture. They are of service only if the splints occasion œdema (which, however, if properly applied, they rarely do). If they are used, it is necessary to examine the limb frequently, lest hidden mischief supervene. The early application of circular compression has, on several occasions, given rise to fatal gangrene, which has not been manifested by pain or any other symptom till too late. The many-tailed bandage, or the bandage of Scultetus, is useful in inflamed and compound fractures for the retention of dressings, the absorption of discharge, and the approximation of the sides of the wound.

Most fractures may be conveniently treated with splints. Pasteboard splints, which admit of being accurately moulded to the limb, may be used for nearly all fractures in children, and for those of the phalanges in adults. In other cases the support they give is insufficient. Metal splints are for the most part cumbersome. The length of splints must vary according to the purpose which they are intended to answer, and the limb to which they are to be applied. Their proper use is to preserve steadiness of the fragments without compressing the actual seat of fracture. Pott accordingly lays down a rule that they are to include the joints above and below. In fractures of the leg this is to be universally observed, because all kinds of displacement are thus obviated. But the rule is not absolute. In fracture of the femur, the prominence of its condyles and the thickness of soft parts would annul the efficacy of splints so placed. The same is the case with the humerus; and in fractures of the upper extremity generally, flexion of the joints is a positive bar to the application of the law. But splints confined to the length of the shaft of the bone have less power over angular displacement, and little or none over rotation. Whenever the movements of a joint would derange the fragments, that joint must be confined by the splints. This is specially the case with fractures of the phalanges, and those in the neighbourhood of the joints.

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* For the description and use of the various apparatus, see the articles on the special fractures.

A good occasional substitute for splints is found in junks, which, enclosing three sides of the limb, on all of which they make equable compression, sometimes succeed in overcoming displacement, even obstinate riding, where splints fail.

At sundry times various kinds of circular splints have been invented, so made as to surround not only the fractured limb, but the adjoining part of the trunk. But as they are costly and inconvenient, and answer no purpose which cannot with some pains be attained by more simple means, they have rapidly fallen into disuse.*

By hyponarthecic apparatus is meant that which merely supports the limb beneath, leaving it free and exposed to view elsewhere. The indications aimed at in its employment are two: position (many of its forms having special arrangements for flexion), and exposure of the limb for examination and the application of dressings. For the latter object they are indispensable in the treatment of inflamed and compound fractures, being the only forms of apparatus which can reconcile the proper care of the wound with firm retention of the fragments. In other cases their utility varies according to the kind of fracture to be treated. It is manifest that, unless combined with splints, they are capable of opposing but a slight obstacle to lateral or angular displacement. But, on the other hand, it is easier to maintain extension with them, and they are recommended by simplicity and facility of application.

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* For an account of such machines, see Wiseman's and Heister's works. Also Lafaye, in *Mém. de l'Acad. de Chir.* t. ii. p. 403; and Bonnet, *Mém. sur les Frac. du Fémur*, &c. in *Gaz. Méd.*, 1839.

The great mass of apparatus recommended by different authors bespeaks alike the great facility with which some fractures are treated, and the insuperable difficulties presented by others. In these latter a selection can only be made by strict attention to the indications to be answered. These are commonly but two: fixation of the fragments, and their maintenance in apposition by opposing the particular kinds of displacement present. In some cases there is a third: exposure of a certain part of the limb, for the treatment of local complications. The greatest difficulties are created by shortening, and numerous methods of maintaining permanent extension have been devised. The most simple and most common is direct traction, as provided for in Desault's thigh-splint, and in many forms of hyponarthecic apparatus. A clumsy form of traction, formerly much in vogue, and not yet discontinued in Paris, is to attach the extending and counter-extending forces to the foot and head of the bed; a weight hanging over the end of the bed, and even a windlass, has been used. A second mode of extension is the conversion of a contiguous bone into a lever, as the humerus in the treatment of fractured clavicle, or the femur in fractures of the leg. And, inasmuch as shortening cannot occur, except in impacted fractures, without producing some degree of lateral displacement, so the lateral pressure of splints or junks, by the obstacle which it presents to the one, is often sufficient to counteract the other. This is the feeblest mode of producing extension; nevertheless, in most fractures of the upper extremity, and many of the leg, no other is required. Only care must be taken that the lateral pressure be not carried to an injurious extent. In all cases of very oblique fracture, where the fragments readily glide upon one another, union will be greatly accelerated by firm lateral pressure either by splints, pads, cravats, junks, or by Amesbury's apparatus. There are cases, however, in which great obliquity, and frequent spasms, aided perhaps by great muscular power and irritability of the patient, or by tenderness of the skin, precluding the employment of much pressure, or necessitating frequent change of apparatus, will render all these means nugatory.

In compound fractures the difficulty of retaining the fragments has been occasionally met by ligature or suture of the bones. Ligature by brass, silver, or lead wire has been very rarely adopted.*

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* Icarte, *Lettre en réponse à M. Pujol*, in *Jour. de Méd.*, 1775, p. 164.

Suture is more feasible and more efficacious; but not often necessary, nor altogether free from danger.*

It is seldom possible to obtain absolute immobility of the fragments. Neither is it essential, though M. Bonnet in France, and Amesbury in this country, have insisted on its necessity, and the insufficiency of ordinary apparatus (vide infra, p. 797). It is usually enough to warn the patient to restrain his own movements during the first few days. Only in the cases of children, of restless, delirious, and maniacal patients, are greater precautions necessary. In children immovable apparatus may safely be used at an earlier period than in adults; but, on account of the delicacy of their skin, greater care is necessary to avoid tight pressure. In consequence of their habits, the apparatus must be protected from urine, &c. In cases of delirium it is sometimes absolutely essential forcibly to restrain the patient by strapping him, as well as the injured limb, to the bed. In such cases some form of immovable apparatus should be applied as early as possible.

In all cases the fracture must be examined from time to time,—to see that coaptation is not disturbed, necessitating readjustment. This can usually be done without deranging the apparatus. But, whenever any kind of circular apparatus is employed, it must be removed for the purpose after all swelling has subsided, and before union has too far advanced; viz. after the lapse of from one-half to two-thirds of the time requisite for consolidation.

When the period ordinarily required for union has elapsed, a careful examination of the limb must be made before it is allowed to resume its functions. Sometimes, even when examination by the hands gives an impression of firmness, yet the incompleteness of union will be manifested by the supervention of pain during use of the limb, in which case the treatment must be resumed. After the union of a simple fracture, there is rarely much impediment to immediate freedom as soon as the apparatus is removed. Even in fractures of the lower extremity, the liberty enjoyed by the patient during the latter part of the treatment gives him confidence and earlier use of the limb, besides diminishing the risk of œdema. But the restoration of the functions may be impeded by two causes; atrophy of the limb, and stiffness of the joints.

Atrophy is generally the consequence of prolonged suppuration; but occasionally it proceeds from the excessive pressure of apparatus in the early treatment. It gradually yields to tonics, position, and gentle exercise of the atrophied muscles.

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* Laloy, *De la Suture des Os, &c., Thèse inaug.*, Paris, 1839.

Stiffness of the joints arises from two causes; inflammation, when the fracture has been in their neighbourhood, and long-continued immobility. Even when the joint is in no degree implicated in the fracture, long confinement in one position, especially extension, induces partial immobility of the joint. This effect is due mainly to a tonic contraction of the ligaments, and, in a minor degree, of the tendons. The muscles also become more or less retracted, and lose both volume and power; but their influence in fixing the joint is much less than that of the ligaments. It also appears, from certain observations of M. Tessier,* that long-continued fixed extension of a joint is capable of setting up in it (by the mutual pressure of the articular surfaces) a real inflammation, with its consequences, viz. formation of false membrane, destruction of the cartilage, and partial anchylosis. There is but one mode of avoiding this disastrous result in all cases in which it is threatened; viz. gentle exercise of the joint from the earliest possible period, that is, from the earliest period at which such exercise will not interfere with the union of the fracture. The observance of this rule is of especial importance in fracture of the upper extremity; the effects of anchylosis being there most disastrous. The treatment may be assisted by frictions, emollients, and douche baths; but these are to be regarded as secondary to constant exercise.

At any period, till the new bone has acquired perfect solidity, it is liable to bend or break from the weight of the body, from blows or falls. This accident is not rare. Accidental bending of the femur has been seen so late as the 135th day,† and refracture eight or eighteen months, and even two or three, and in one case seven years after the first;‡ but in these extreme cases union has been delayed, or, from deformity, has never been strong. These secondary fractures unite more readily than the first, from the spongy nature of the new bone; and curvature readily yields to pressure.

Treatment of compound fracture. Although the rules of treatment laid down for simple fracture are equally applicable to compound, yet the latter present certain special points for consideration, viz. the reduction of a protruding fragment; the treatment of splinters and loose pieces of bone; and the mode of dressing the wound.

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* *Gaz. Médicale*, 1841, pp. 609, 625.

† Guillon, *Thèse inaug.*, Paris, 1820.

‡ Œsterlen, op. cit. obs. 21-30; and Malgaigne, op. cit. p. 326.

It is usually the upper fragment which protrudes. When the wound in the skin has been made by the pressure of the fragment itself, it is commonly small, and occasionally girts the bone tightly. The difficulty of reduction is in proportion to the size of the wound, the length of the protruding bone, and the degree of accompanying spasm. If reduction cannot be effected by moderate extension and dexterous manœuvring, the wound must be enlarged. But although this measure is attended with far less danger than violent efforts of extension, it is yet to be adopted as sparingly as possible. The enlargement is to be made in that direction in which the smallest additional division will give the greatest amount of freedom. This will usually be in the axis of the bone. If, on account of the length or sharpness of the protruding piece, even this is not sufficient, the end of the bone, so far as necessary, must be sawn off. In compound, as in simple, fractures, excessive spasm may render it necessary to postpone complete reduction, but under no circumstances may the bone be allowed to remain protruding.

If the bone is splintered or comminuted, some judgment is required in determining what pieces to remove and what to leave. Splinters are of three kinds. Some, though split away from the bone, are still connected to it in their whole length by the periosteum, to which they are firmly adherent. These, in young and healthy subjects, are not to be touched; they become reunited to the bone; they rarely die. But in the old, and in cases of gunshot wound, it is prudent to remove them. Others are completely torn away from the bone, and are found lying loose among the surrounding tissues. All these are to be carefully removed, whether they carry with them their periosteum or not. If, being at a distance from the fracture, they are not easily reached through the wound, a counter-opening may be made for the purpose. A third set are partly adherent, partly not. These may reunite: more commonly they partially die, in proportion to the injury to their periosteum, and keep up for a long period,—for months, perhaps for years,—a succession of abscesses, retarding, or entirely preventing, union, greatly prolonging the danger, and involving, it may be, the ultimate loss of the limb. They must, therefore, so far as is practicable, be removed. But some allowance may be made for differences in their position. If they are at the bottom of a deep wound, and difficult to reach, it is the better and less hazardous course to make no attempt at interference. Such attempts have resulted in gangrene and death.* On the other hand, should the fracture be in the neighbourhood of a joint or of a visceral cavity, on no account may they be suffered to remain. They are even more injurious there than elsewhere. In the treatment of these fractures the most perfect clearance of all loose fragments is the first requisite. The bones of the face, however, except the lower jaw, are so well supplied with vessels, and their repair is so energetic, that much more latitude is allowable in dealing with splinters in their fractures than in others, especially as it is more than usually desirable to avoid deformity in that region. All sharp projections of the splinters which are left, or of the fragments themselves, should be nipped off; they may wound or lacerate the soft parts, or open some vessel. For the purpose of removal (which should be done by the fingers in preference to instruments), it may be necessary to enlarge the wound. In all cases, all tendinous or membranous structures which obstruct the removal, or unduly confine or strangulate the soft parts during the subsequent inflammation, are to be freely divided.

If there is hæmorrhage, it is to be treated on the same principles as in other wounds, the employment of pressure being, however, somewhat limited by the state of the bone. Then the wound is to be dressed, and the mode of dressing it depends on its nature. It must always be remembered that the primary object is the conversion of the fracture, if possible, from compound to simple. If the wound is small, its lips smoothly cut, and but little bruised, and especially if it was made by the protrusion of the end of the bone, this object may often be gained. It should then be closed, and its edges approximated by some unirritating dressing, as isinglass-plaster, or, after the practice of Hunter, by lint dipped in blood. If the wound is large and lacerated, with much contusion of its lips, primary union cannot be anticipated, at least for its whole extent. Nevertheless it may generally be attempted; for if any portion unites, it is an advantage. All shreds of lacerated muscle or tendon, which tend to aggravate the suppuration, should be cut away.

There are but two classes of cases in which sutures are admissible: firstly, when an endeavour is made to save a limb, as a finger or hand, which is nearly divided across; and secondly, when the skin is peeled off from the underlying tissue. In all other cases they must be regarded as useless irritants.

As soon as it is clear that the effort at primary union has failed, the first dressings are to be removed, and the wound to be treated according to its condition, as though it were uncomplicated with fracture. For the fracture only modifies its condition by permitting motion, and the consequent interference with the natural process of union. Nevertheless, this interference is so great as to occasion, in many instances, the severest form of suppuration.

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* See a case related by Bessière, in which an attempt was made to remove a ball and splinter from between the radius and ulna, *Des Complic. des Fractures, Thèse inaug.*, 1851.

Whatever form of apparatus be used, ready access to the wound is indispensable. Accordingly, all circular apparatus, movable or immovable, is to be rejected. The former requires constant renewal, with disturbance of the limb. Immovable apparatus, covering the wound, was employed by Larrey. Then the pus accumulates, soaking the dressings, diffusing itself over the limb, putrefying and generating worms, and, in some instances, burrowing largely among the muscles. These accidents are by no means uncommon, and, with the exception of the last, are treated by Larrey as of no account. To avoid these evils, others leave a window opposite the wound; then its borders being the only free parts in the midst of compression, are liable to become turgid, and angry, and unhealthy.

Complications. A fracture in a healthy subject, whether simple or compound, unaccompanied by inflammation or fever, demands little or no constitutional treatment. Even the slight antiphlogistic regimen usually enforced after an accident should be modified, in consideration of the great labour of repair which is to follow. In fractures of the lower extremities aperients must be avoided, on account of the movements which they necessitate.

Complications are either local or general. The former include affections of the skin—pruritus, vesications, excoriations, wounds, and erysipelas; of the vessels—ecchymosis and hæmorrhage; of the areolar tissue—inflammation, suppuration, and gangrene; of the bone—inflammation, caries, and necrosis; of the muscular and nervous tissues—spasms, convulsions, paralysis, and neuralgia; and lastly, of neighbouring organs, the joints or viscera.

These complications may be produced simultaneously with the fracture, or may arise at a later period. Of course, for many the treatment is not influenced by the coexistence of the fracture. Pruritus is almost always the result of improper dressings. If the skin is much distended, especially when the fracture is superficial, as in the leg, there commonly arise, in a few hours, several vesications filled with a light-coloured viscid fluid. If let alone they either burst or shrink from absorption of their contents. Much relief to the sensation of tension is afforded by pricking them, without removing the cuticle. They must not be confounded with the vesications of erysipelas, which are numerous and clustered, small, tense, and surrounded by the peculiar blush of that disease; nor with those which precede mortification, whose contents are dark and tawny.

Fracture of the bones enclosing a visceral cavity is not necessarily accompanied by any injury to the viscera themselves. When it is, the latter is to be treated as the primary injury, influenced by the fracture in two ways; by the movements of the fragments, or by the pressure or irritation of displaced bone, or of a splinter.

The same considerations apply to fracture extending into a joint. As this accident must, in most instances, lead to anchylosis, the joint should be placed, from an early period, in the best permanent position.

When a fracture is accompanied by dislocation, the attempt to reduce the latter must be made at the outset. The possibility of its reduction depends partly upon the kind of joint affected, and the nature of the dislocation, but principally upon the situation of the fracture. Dislocation of a ginglymoid joint may generally be reduced, especially if its ligaments are weakened by laceration. But if it be an orbicular joint, deeply buried among powerful muscles, and the fracture be below it and in its immediate neighbourhood, reduction is not possible. Neither will it be possible after union of the fracture; at least, there is no instance of it on record. Nevertheless it will, of course, be right to attempt it; with which view the muscles and ligaments of the joint should be, as much as possible, relaxed by habitual movements from an early period of the treatment. Boyer also recommends for this purpose the use of emollients.

The general complications are such as are common to all injuries, viz. inflammatory fever, hectic, delirium tremens, purulent infection, phlebitis, tetanus, and retention of urine.

In a certain proportion of cases, one or more of the above complications will necessitate either primary or secondary amputation. There are but two conditions which demand immediate amputation: profuse hæmorrhage, and extensive injury to the soft parts, threatening excessive inflammation or mortification. But the cases presenting one or other of these conditions are various:

1st. When a limb is shot off by a cannon-ball or a portion of a shell.

2d. When the division of the soft parts is nearly complete; except in the case of a clean cut across the phalanges, metacarpus, or metatarsus. Even the forearm may occasionally be saved under similar circumstances.

3d. When there is much actual loss of soft parts, as when one side of a limb is torn away or the skin is extensively peeled off.

4th. When, in addition to great comminution of the bone, there is so much bruising and laceration, with deep separation, of the soft parts, especially of tendons, that gangrene appears inevitable. These cases, however, except as the result of gun-shot wounds, are very rare. In healthy subjects, the tissues, unless absolutely destroyed, will for the most part recover. In a few cases, specially noticed by Velpeau* and Malgaigne,† the parts in the neighbourhood of the fracture are within a few hours attacked by spontaneous emphysema, without any communication with the lungs. It appears to be simply an early symptom of gangrene from the sudden death of the part, and demands immediate amputation.

5th. When a fracture, effected by some large body, as a wagon-wheel, is accompanied by laceration of the muscles and destruction of important nerves, but not of arteries.

6th. When the principal artery and nerve of the limb are both divided.

7th. Some cases of hæmorrhage. A wounded artery alone is not sufficient to justify the operation. But if it be accompanied by much laceration of the other tissues, the issue will depend very much on the position of the artery. If it be the brachial, the limb may generally be saved; if the femoral, it must be sacrificed. A wound of the posterior tibial, where it is deeply covered by muscles, or of the interossei in the arm, may resist all other treatment. Amputation will occasionally be rendered necessary by general hæmorrhage from a number of small branches, especially when it is persistently induced by warmth. There are, indeed, cases on record where it has been required in simple fracture of the tibia, in consequence of continued oozing from the divided medullary artery. There is a peculiar form of injury mentioned by military surgeons, ascribed by some to the wind of a cannon-ball, but by Larrey, with more probability, to a spent ball, in which, without any division of the skin, bone, muscles, and tendons are crushed, and the artery lacerated. Before amputation, the skin should be divided and the parts examined, as it may be that the muscles are the only soft parts injured, in which case the limb may be saved.

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* *Médecine Opératoire,* 2d ed. t. ii. p. 321.

† *Traité des Fractures,* &c., 1847, p. 351.

8th. Several forms of compound fracture of large joints, viz. when either bone of the joint is shattered, or both are broken; when there is much destruction or laceration of the ligaments; when, in addition to comminution of the bone, there is much contusion of the soft parts, especially if complicated with division of an artery; when the articular surfaces both of the bones and ligaments have suffered much damage, accompanied by effusion into the joint; when there is displacement of the fragments within the joint, and they present rough edges, as in the case of separation of the condyles of the femur, transversely from the shaft or perpendicularly from each other, in consequence of the passage of a ball; when the foreign body which has caused the fracture remains in the joint, or projects into it from its bed in the bone, and cannot easily be removed, or when, in its passage through the joint, it has inflicted great injury on the articular surfaces; and, lastly, in the case of an extensive incised wound into a large ginglymoid joint, with internal effusion of blood. It is to be understood that all these forms of injury are most fatal when affecting the knee; in dealing with other joints much greater latitude may be allowed. Moreover, whenever the injury is confined to the joint, with little or no damage to the neighbouring soft parts, excision may be substituted for amputation.

But although it is true that under most of the above conditions salvation of the injured limb is well nigh hopeless, and the attempt would jeopardise the life of the patient, yet it must be admitted that the discrimination of the cases in which that attempt may reasonably be made is frequently a matter of difficulty, and has created much discussion. For, besides the extent, kind, and position of the injury, the age, constitution, and habits of the patient materially influence the result. Many limbs may be preserved in the young and healthy which must otherwise have been sacrificed. Moreover, with them greater risks may be incurred, as they are better able to encounter the dangers of secondary amputation, if it become necessary.

If, in addition to the fracture, there are serious injuries to other organs, immediate amputation is either useless or injurious. In such a case the only chance of recovery is afforded by secondary amputation after the early dangers are past.

Secondary amputation may, of course, be required for profuse suppuration with hectic, for gangrene, or uncontrollable hæmorrhage. These, being common to other forms of injury, demand no special notice.

At a still later period, after all danger has ceased, the operation may be desired by the patient, if, in consequence of non-union, incurable deformity, or tedious disease of the bone, the limb has become an incumbrance to him. Similar circumstances may occasionally be met by excision.*

Process of union. Notwithstanding the labour which has been bestowed upon the study of the healing process in bone, the greatest misconception of its nature has, till within the last few years, prevailed, and many of its details remain yet to be determined. This is due to many causes: the nature of the tissue; the scarcity of opportunities for examination of the various stages of the process in man; its essential difference in animals, on which alone experiments could be made; and, lastly, actual differences in different fractures, according to their varying conditions.

The injury is seldom limited to the bone, but is accompanied by more or less bruising and laceration of the neighbouring soft tissues and surrounding extravasation of blood. This extravasation varies greatly in quantity, and is unequal in its distribution. If no considerable vessel is torn, it is in proportion to the displacement and sharpness of the fragments, and the extent of injury to the periosteum. It is most abundant in the subcutaneous cellular tissue. Here, too, its absorption is least rapid; Paget having found it, in one case, nearly unchanged after a period of five weeks. In the periosteum and medullary membrane there is usually little or none. The periosteum is rarely much damaged in simple fracture. It is not often stripped off, but is generally simply torn across, and slightly frayed at the edges, but retaining firm union to the bone up to the level of the fracture. In partial fractures it is frequently uninjured. It may even remain entire in complete fractures, especially in children, in which case it subsequently thickens, contributing to the facility and security of the repair.

During the first two or three days there is a slight inflammatory exudation amongst the soft tissues. Only in the severer cases does this amount to distinct swelling, perceptible for many days, and accompanied by general fever. It is succeeded, according to Paget, by a period of rest, of incubation, lasting for a week or ten days, or even more, during which absorption of the blood and effused fibrine proceeds; but the proper reparative process is suspended. Meanwhile the deep-seated muscles, in all cases more or less lacerated, are found adhering together and to the neighbouring soft tissues and periosteum, their torn ends rounded off and lost in the fibrinous effusion. About the sixth day their repair has commenced, and is completed by cellular tissue some time before the union of the bone is effected. About the end of the first month they have lost all adhesion to the periosteum.

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* Excision of the knee has been performed for mal-union of the patella. *Med.-Chir. Trans.* vol. xli. p. 195.

The proper reparative process of the bone is precisely analogous to that of soft tissues. It is divisible into two parts, as distinct in their objects as in the time which they occupy, the former being completed, or nearly so, before the second begins; viz. the actual process of union, and the subsequent shaping of the fragments and of the uniting substance.

In a few cases, immediate union occurs without the intervention of any new material. According to Paget, this is very rare: but Hamilton considers it to be a frequent, if indeed it be not the normal mode of union in spongy bones, and the spongy extremities of long bones, especially after impacted fractures, as seen in the neck of the humerus and femur.

In the great majority of cases, however, a proper reparative material is provided, precisely similar in its early growth to that employed for the repair of soft tissues by adhesion. This material is of course supplied mainly by the vessels of the bone itself and of the periosteum; in a minor degree by those of the medullary membrane; and secondarily, through the intervention of the above, by the vessels of the surrounding tissues. The period of its first effusion in man cannot, as yet, be accurately stated; probably it is between the tenth and twentieth days in fractures of the large, but earlier in those of the small, bones. If the injury to the neighbouring tissues be but slight, and the fragments have been, from the first, kept at rest and in strict apposition, this material is found chiefly, or it may be solely, between them. When it extends beyond them, it occupies, indifferently, the tissue of the periosteum, the space external to it, or between it and the bone; variations in this respect depending probably on the degree and nature of the injury to the periosteum itself. It extends slightly into the medullary tissue, but not between it and the bone. The extent of its external diffusion may vary on different aspects of the bone. In fractures of superficial bones, as of the tibia, it not unfrequently happens that the deep surface is rough with deposits, from which the superficial is perfectly free.

The transitional forms through which this material passes in its development into bone are not in all cases the same. In a few, ossification is preceded by the production of perfect fibrous tissue.

This is the case in the union of fracture of the cranium, and, perhaps, of other flat bones; in some slowly uniting fractures of long bones; and in the closing of the exposed end of the medullary canal, when the fragments overlap. More frequently, however, the deposit of earthy matter proceeds simultaneously with the development of the fibrous matrix, so that the rudimental nucleated blastema appears to be at once developed into bone. This is stated to be the normal form of ossification in the repair of quickly-uniting fractures. Lastly, in some cases, especially in young subjects, the development is through fibro-cartilage. In animals, genuine cartilage is commonly, perhaps always, produced. Hence it has been conjectured that it may be found, occasionally at least, in children. But although the general appearance of the new tissue has been adduced in support of this conjecture, it has not as yet been proved that it is ever more in the human subject than fibro-cartilage.

Whichever of the above modes be followed, ossification may commence either at the surface of the old bone, or in several separate centres. The corpuscles, at first round, rapidly shoot out and acquire their peculiar characters. Then the Haversian canals are formed, and subsequently canals for blood-vessels. For some time the new bone is porous and spongy, like fœtal bone; its change into compact bone is very gradual.

When the fragments do not accurately correspond, the uniting medium occupies externally the angle between them, and extends partly into and across the medullary canal. When they completely overlap, and even when there is an interval between them, provided it is not too great, the same rule prevails. The reparative material simply lies between them, bridging over the interval, and filling up all angles and irregularities. It does not occupy any part of the medullary canal; it does not even cover the exposed ends of the bone.

Under certain circumstances this process undergoes a modification so marked, that its essential identity with the process of union in other tissues was long overlooked. Of universal occurrence in animals, and therefore observed in all experiments, this modification was first fully described by Dupuytren, on whose authority mainly it was accepted, till recently, as the sole and normal mode of union of simple fractures. It consists in the production, at an early period, of a ring or 'ferule' of bone around the fragments, called by Dupuytren 'provisional callus,' and constituting a kind of natural splint, beneath which the permanent union by intermediate or 'definitive' callus takes place much later. The whole process was conveniently, though artificially, divided by Dupuytren into five periods.

In the first, comprising in animals eight or ten days, the peculiarity of the process is already seen in the more copious exudation of the reparative material, both externally to the fragments, between them and the periosteum, and internally, but to a less extent, between the medullary membrane and the bone. By the fourth day this exudation contains cartilage-cells, which rapidly multiply, so that by the eighth or tenth day it exhibits the structure of soft cartilage.

In the second period, from the tenth to the twenty-fifth day, while the muscles are separating from the periosteum, the soft external or 'provisional' callus gradually acquires firmness, with the perfect structure of cartilage or fibro-cartilage. It is frequently contracted immediately opposite the fracture, and adheres closely to the surfaces of bone beneath. The same change takes place in the internal callus, or 'plug,' which gradually fills up and obliterates the medullary canal, being blended with the substance between the fragments.

In the next stage, both the external and internal callus ossify, ossification commencing in the parts farthest from the fracture. The period occupied by this change is variable. According to Lebert, bone-corpuscles are visible in the callus, especially near to the old bone, so early as the tenth day; so that ossification is complete by the thirty-third day. Dupuytren, however, assigns it to the period between the twenty-fifth and forty-eighth, or even the sixtieth day. The new bone at first consists of spongy tissue; but in the fourth period, from the fiftieth day to the fifth or sixth month, it is stated to become compact. In by far the majority of cases, however, this change does not take place; the callus remains spongy, or becomes compact only on its surface.

Lastly, about the fifth or sixth month, the intermediate tissue ossifies, forming the permanent bond of union, or 'permanent callus.' In a very few cases, however, there appears to be an arrest of development previously to this last change, so that there is never any direct union of the fragments; the temporary callus becomes permanent. Malgaigne, following the theories of Galen, Haller, and Duhamel, incorrectly represents this as a usual and normal occurrence, imagining that the permanent callus is met with only when the external has been absorbed by pressure.

The only bones which normally and constantly unite by this process, in man, are the ribs. Occasionally it is seen in the clavicle and humerus; rarely in the tibia, fibula, and other bones. In children, however, it is more frequent; according to Hamilton, almost constant. Although Dupuytren entertained the idea that the provisional callus was intended as a temporary support during the early stages of union, there appears no just ground for regarding it in any other light than as the natural result of the irritation generated by the perpetual motion of fragments invested by much areolar tissue.* For in certain fractures, as those of the olecranon, acromion, coracoid, and cranium, it is rarely met with, only when there has been excessive irritation; and never in the fractures of parts surrounded by synovial membrane, although in them it would be of especial service for the supposed purpose. The tardy ossification of the permanent intermediate tissue may arise from the mechanical obstruction of the external ring of bone.

A condition in many respects analogous to that just described is met with in the repair of certain fractures in the neighbourhood of joints, especially of the hip-joint, when accompanied by much deformity, in which strengthening buttresses of bone are thrown out, on the concave side, manifestly as the result of irritation.

In inflamed simple and in compound fractures a third mode of union is met with, viz. union by granulations.

In compound fractures there is usually greater injury to the soft parts than in simple. Either they are crushed and their vital powers annihilated at once, or great inflammation is followed by extensive suppuration and sloughing. The periosteum is generally torn away from the bone, and the medullary membrane is either crushed and lacerated or involved in the subsequent inflammation. The inflammatory effusion among the deep muscles generates a capsule around the fragments, arising from the healthy bone beyond the torn periosteum. In the majority of cases, the ends of the bone, thus lying in a closed abscess and bathed in pus, die, the necrosis being limited by the extent to which the periosteum and medullary membrane are torn away. After the separation of the sequestrum, granulations spring up from the exposed surfaces and ossify. If the necrosis does not involve the whole thickness of the bone, partial and imperfect union may take place before the separation. Generally the slow exfoliation and the lengthened suppuration so weaken the powers of the part and of the constitution that ossification is tedious and may be altogether arrested. Even when there is no necrosis the progress is in all other respects the same. After the completion of union the adaptation of the fragments is generally less perfect than after simple fracture; morbid deposits of bone from inflammation are more frequent and more irregular, and there is greater adhesion of the tissues one to another. This is especially observable after compound fractures of superficial bones, as the tibia, to which the skin is often long adherent.

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* Paget suggests a second reason for its constancy in animals,—a greater general tendency in them to the production of bone. *Lectures on Surg. Path.* vol. i. p. 240.

The changes which occur in the latter part of the process of repair, viz. the shaping or modelling of the bone after its union is complete, so as to restore it as nearly as possible to its original condition, are these: 1st. All rude and unnecessary projections are removed by absorption. The sharp points left by the overlapping of ill-united fractures, whether deep or superficial, are first softened by the disappearance of their earthy matter, and subsequently removed and rounded off. It has been questioned whether, after the repair by provisional callus, this callus, once ossified, is absorbed. The absorption is certainly not complete. In most ribs that have been broken there remains more or less enlargement at the seat of fracture. M. Lambron refers all absorption to the continual pressure and friction of the muscles.* 2d. When the fragments overlap, the exposed ends of the medullary canal are closed by a layer of compact tissue. 3d. The new bone, at first uniform in structure, has to acquire the firmness and strength of compact bone externally, and internally to be hollowed for a new medullary canal. Whatever the relative position of the fragments, the medullary canal usually becomes continuous in the two. Even where they overlap, their compact walls are absorbed, and the cancellous tissue and canal of the one become eventually continuous with those of the other. It sometimes happens, however, that the plug which is formed in the process of union by provisional callus remains as a permanent septum. For a long time after union the new bone is more vascular than the old, and contains more animal matter.† Generally, in the course of a year or little more, all the tissues concerned are restored to their normal state, however much their relative positions may be altered.

If the coaptation of the fragments is good and union healthy, the old bone itself undergoes no change. Curling, indeed, has endeavoured to show that, in fractures of long bones, the fragment which is cut off from the nutrient artery becomes more or less atrophied;‡

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* *Thèse Inaug.*, Paris, 1842.

† Von Bibra, in *Chem. Unters. über die Knochen*, &c., 1844, p. 305; and Howship, *Med.-Chir. Trans.* vol. ix. p. 143.

‡ *Med.-Chir. Trans.* vol. xx. p. 336.

but his theory has received no support from other observers. But if there is great overlapping, with tedious union, both fragments suffer more or less atrophy; they are shrunken and conical, and their cells enlarged. The same condition may result from other causes of local debility or tedious union.

The time requisite for the various stages or for the completion of union can never be predicated with certainty. No deductions from experiments on animals can be applied to man. Only approximate dates can be given. Ossification, in the ordinary mode, in simple fractures, is rarely completed before the ninth or tenth week, even under favourable conditions. This period is subject to variation from many causes; the age of the patient, the size and situation of the broken bone, the nature of the fracture, and the relative position of the fragments.

In infants fractures unite with marvellous rapidity. Ten or twelve days are often sufficient for the forearm or humerus. On the other hand, in old age the period is greatly protracted, in proportion to the want of vigour of the individual. *Cæteris paribus*, the larger a bone, the longer the period it requires for its union. It may be on this account alone that the bones of the lower extremity appear to unite more slowly than those of the upper. But, however this be, the position of the former, throwing upon them much more violence and weight, prolongs the period necessary for the treatment of their fractures, which ordinarily require the retention of apparatus from eight to twelve weeks, while three or four suffice for those of the upper extremity.

The relative position of the surfaces of the fragments has the most marked influence over the rapidity of union. If they overlap, it is proportionately retarded. If, in addition to overlapping, they are more or less separated; or if they are very oblique and smooth, so that they readily glide one over the other; or if they touch only by their periosteal sides, nearly double the ordinary time will be required for their union, partly, no doubt, in consequence of the difficulty of maintaining them at rest. Cases of double fracture, in which it is difficult or impossible to prevent riding, are always tedious.

Compound fractures demand, on an average, three times the period required for simple. The most tedious are gun-shot wounds, on account of the extensive comminution of the bone, and the damage to the soft parts. Next to them are clean cut fractures, in which nearly all the tissues are divided.

When there has been actual loss of bone, in consequence either of the removal of splinters or comminuted portions, or of sawing off the end of one of the fragments, the extent of restoration varies in different cases. In most instances it is little or none, and the limb is permanently shortened to the extent of the loss. Many remarkable cases, however, are recorded of the regeneration of large pieces of bone, generally in the tibia. Delamotte mentions one in which no less than six inches of this bone were restored.* In another, related by Gooch,† five inches; and in others, two, three, four, or five inches‡ have been replaced. The more favourable cases of this kind occur in young subjects, and the restoration is effected by the ossification of effused lymph. The more it is by granulation the less perfect is it. From the recent experiments of M. Ollier,§ confirmed, as they have been, by others, it appears that the restoration is exactly in proportion to the integrity of the periosteum, the preservation of which membrane is therefore of the first importance in all cases of resection.

Perforations of bone by balls, or other foreign bodies, generally become filled, more or less, with new bone. When the perforation is large, bony offshoots from the edges partially, but never completely, close it.

A fracture extending into a joint is never followed by reunion of the articular cartilage. There is always on the second or third day, or even earlier, more or less synovial inflammation. In simple fracture this may subside without further mischief; the bone unites, leaving an interval between the borders of the cartilage, which may or may not be filled with fibrous tissue. In more severe cases, a false membrane may form on the synovial surfaces; or inflammation extends to the cartilage which is more or less eroded, and a cure is effected by fibrous, or, rarely, by bony, anchylosis. In compound fractures some degree of destruction and subsequent anchylosis is inevitable, in proportion to the size of the joint, and the nature of the fracture. Rarely, indeed, does a fractured joint entirely recover its functions.

Separations of epiphyses unite by the same process as fractures. But if the union is vicious, and the separated epiphysis is the head of the humerus or femur, this accident is invariably followed by atrophy of the limb, from imperfect growth of the injured bone; the consequence, apparently, of the partial destruction of the fibrous layer connecting the epiphysis to the shaft.

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* *Traité Comp. de Chirurgie*, obs. 80.

† *Cases and Prac. Remarks in Surgery*, 1758, p. 97.

‡ Recorded by Phillips, Van Swieten, and Dunn. See *Obs. on Compound Fractures*, in *Med.-Chir. Trans.* vol. xii.

§ *Recherches Exp.* &c., in Brown-Séquard's *Journ. de la Phys.* Jan. and April 1859.

Ununited fractures. The process of union may be delayed or completely arrested at any period of its progress. But, inasmuch as the time requisite for consolidation is very variable, and there are no signs by which to determine the precise period of arrest, the distinction between retarded union and non-union is more or less arbitrary. They both acknowledge the same causes, and demand similar treatment.

Certain fractures, from special causes, rarely unite by bone. They are, fracture of the neck of the femur, of the condyles of the humerus, of the olecranon, coronoid process, and the patella.

Ununited fractures are, fortunately, rare. Amesbury,* indeed, states that he had in 1828 seen fifty-six cases, and some years later ninety; but his experience is quite exceptional. Lonsdale† found that, of 4000 fractures treated at Middlesex Hospital, only four or five refused to unite: Norris‡ did not meet with one case out of 946 fractures; the cases which he saw were sent from elsewhere. Liston met with only one in his own practice; and other Surgeons give similar testimony. Hamilton reckons that they do not exceed one in 500 cases, and even this estimate appears high. They are more frequent in males than in females. The relative liability of different bones is exhibited in a table of 150 recorded cases drawn up by Norris. Of these, forty-eight occurred in the femur, forty-eight in the humerus, thirty-three in the leg, nineteen in the forearm, and two in the lower jaw. Other bones, however, are not exempt; instances having been met with in the clavicle, ribs, acromion, and even the spine.

The mode of connexion of the fragments is of four kinds: 1st, In a few cases, they are enclosed in a mass of fibro-cartilage. This may be provisional callus arrested in its development, or the result of subsequent irritation. This variety of union is always painful under rough handling. 2d, In others, also but few in number, and only in anæmic subjects, there is absolute want of uniting medium of any kind. The ends of the bone are atrophied, loose, and very movable. The limb is shortened, and quite powerless. 3d, Occasionally a genuine diarthrodial joint is established. A strong fibrous capsule, smooth, and secreting synovia, encloses the ends of the bone, which are rounded off and smooth, sometimes covered with cartilage, at others worn down by friction to a hard, or even ivory-like, surface. Both the ends may be flat, or convex; or the convex end of one may be received into a concavity in the other, which is, in that case, somewhat enlarged. Such a condition is mostly to be found in the neck of the femur. But many Surgeons, following the assertion of Boyer, have doubted the existence of this form of union. There are, however, several cases on record. Key* saw an instance in the spinous process of a vertebra; Brodie in a rib; Kuhenholtz† in the femur; Home,‡ Cruveilhier, and Howship§ in the humerus; Langenbeck, Houston,‖ Sylvestre,¶ and Béclard,** confirm their observations. Breschet†† produced it readily in his experiments on animals, in which it seems to be the most common form of union. The false joint may contain an inter-articular cartilage, or several loose cartilages. It is always the result of considerable motion. It is never seen after a compound fracture, when there is always some kind of fibrous connexion. 4th, In by far the majority of cases, the union is by fibrous tissue. This tissue firmly adheres to the bone, and is very pliable. In some cases it is so short as to constitute a kind of synchondrosis between the fragments, admitting scarcely any movement. In others it is long and flexible. It may be entire, or separated into two or more bands. The ends of the bone are commonly smooth and rounded off; sometimes they are shrunken and pointed; at others more or less enlarged by accessory bony growths—a circumstance highly favourable to the prognosis. The medullary canal is closed.

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* *Obs. on Nature and Treatment of Fractures*, &c. pt. ii. p. 193, Lond. 1828.

† *Practical Treatise on Fractures*, London, 1838.

‡ *On the Occurrence of Non-union after Fractures; Amer. Journ. of Med. Sci.* Jan. 1842, art. 1: the most complete article for reference on the subject.

It is not always possible to ascertain the actual condition of the part: but the points to be observed, as bearing practically on the treatment, are, the relative positions of the fragments; their mobility; as far as possible, their condition; the degree and nature of the deformity; and the sensitiveness of the part under manipulation.

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* Sir A. Cooper's *Treat. on Dislocations*, &c. ed. 1842, p. 532.

† *Journ. Complem.* t. iii. p. 289.

‡ *Trans. of Soc. for Imp. of Med. and Chir. Knowledge*, 1798, p. 235.

§ *Med.-Chir. Trans.* viii. p. 517.

‖ *Dub. Med. Journ.* viii. p. 493.

¶ *Nouv. de la Répub. des Lettres*, 1685, July.

** *Anat. Gén.*, Hayward's Trans. p. 149.

†† *Recherches sur la Formation de Cal*, Paris, 1819.

The causes of non-union are constitutional or local. The former include all those conditions in which the powers of the system are much impaired. They are old age, pregnancy, lactation, syphilis, phthisis, fevers, general cachexia, and scurvy.

General fevers and internal inflammation always arrest the progress of union, and may even cause resoftening after its commencement. It is only when accompanied by unusual debility, as in some cases mentioned by Bonn,* that old age is able to retard it. The same is true of pregnancy, lactation, and syphilis, the influence of which has been doubted by some authors.† Schmucher saw union delayed, in unhealthy or scrofulous subjects, for eight or nine months, and in one case for more than a year.‡ Insufficient food, or the want of an habitual stimulus, will prevent union.§ Brodie refers to the examples of two corpulent patients, one male, the other female, in whom an intentional persistence in low diet for some months previously to the fracture had this result.‖ In consequence of bad and insufficient food, almost all the gun-shot fractures which Larrey witnessed in Syria were followed by non-union.¶ It has been traced to the enervation consequent on habitual discharges,** to general dropsy,†† to copious bleeding, followed by low diet.‡‡ Heath, of Newcastle, has noticed that the diet of most of his patients has been deficient in vegetable aliments.§§ But the most marked effects of impaired nutrition are witnessed in scurvy; the power of which not merely to prevent union, but to dissolve it months, or even years, after its completion, have been pointed out by Lord Anson,‖‖ Sir S. Hammick, and Desault.¶¶

In certain obscure cases, in the absence of apparent cause, non-union has been ascribed to some unknown peculiarity of constitution. Two such cases are recorded by S. Cooper,* and five by Sanson.† A clue may, perhaps, be given to at least some of them by an observation made by Penel.‡ He found the urine of his patient alkaline, and loaded with earthy phosphates. In a few cases of tardy union the author has found these phosphates in excess, but not always with alkaline urine. This condition appears to be due to long confinement.

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* Art. 'Fracture' in *Dict. de Méd.* 1836, t. xiii. p. 402.

† For examples of non-union from these causes, see Norris's paper, supra cit.

‡ *Vermischte Chir. Schriften*, b. i. p. 26.

§ *Cases of Ununited Fracture*, by B. Page, *Med.-Chir. Trans.* 1848, p. 135.

‖ *Med. Gaz.* vol. xiii. p. 53, vol. xiv. p. 616.

¶ *Mém. de Chir. Mil.* 1812, t. ii. p. 131.

** Marrigues, *Diss. sur la Form. de Cal*, Paris, 1783; and Thierry, *Expérience*, 1841.

†† A. Cooper, sup. cit. p. 570.

‡‡ Hewson, *Jour. du Progrès*, t. ix. p. 161.

§§ *Lancet*, 1855, vol. i. p. 611.

‖‖ *Voyage round the World*, 15th ed. p. 142.

¶¶ *Journ. de Chir.* t. ii. p. 318.

The local causes are much more numerous. They are either indirect, as inflammation of the soft parts, paralysis, obstructions to the circulation, and local anæmia from bad treatment; or direct, viz. diseases of the bone, the presence of a foreign body, separation of the fragments, and motion.

Local inflammation, or abscess, or an ulcer, usually retards union. Wardrop§ mentions the case of a sailor with compound fracture of the leg, in whom, on three separate occasions, the uniting medium was resoftened in consequence of attacks of erysipelas. A few instances of non-union from recent paralysis have been met with.‖ The result, however, is not constant, at least in paralysis of long standing; for a fractured tibia has been known to unite readily in a man who had been palsied for twenty years.¶

Obstructions to the circulation by pressure upon,** or ligature of, the main artery above a fracture occasions considerable delay of union. This was shown by Brodie in numerous experiments on animals.†† The same is the result of early, tight, or prolonged bandaging. In France, where the treatment by immovable apparatus has been employed much more extensively than in England, it has been found that fractures so treated unite in general but slowly, occasionally not at all;‡‡ and Troja and Duhamel proved experimentally the prejudicial influence of strong pressure over the seat of fracture. Prolonged bandaging, or the excessive employment of emollients and refrigerant lotions in the early treatment produces an anæmic condition of the limb, to which Cloquet* has given the name of local scurvy. The skin is pale, and deprived of its natural secretion; the cuticle separates; the whole limb is shrunken or œdematous. Sometimes points of ecchymosis appear, which extend more or less over the limb. In compound fractures the granulations become soft and livid, readily bleeding, and secreting a thin, ichorous pus. Of course, consolidation of the fracture is arrested.

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* *Dict. of Prac. Surg.* 7th ed. 1838, p. 551.

† *Dict. de Méd. et de Chir. Prat.* t. iii., art. 'Articulation Anormale.'

‡ *Lond. Med. and Phys. Jour.* vol. xiv. 1805, p. 29.

§ *Med.-Chir. Trans.* vol. v. p. 378.

‖ Travers's *Further Inquiry*, &c. p. 436; and B. Phillips, in *Lond. Med. Gaz.*, May 1840.

¶ Busk, *Lond. Med. Gaz.*, 1840, p. 97.

** Davies, in *Lancet*, Feb. 5, 1859.

†† *Med. Gaz.* vol. xiv. sup. cit.

‡‡ *Réponse à M. Rognetta, &c., Gaz. Méd.* 1831, p. 630.

Separation of the fragments is manifestly the cause of non-union in fracture of the patella, and probably in all those special fractures which rarely unite by bone. It is, perhaps, the real obstacle to union in those few cases in which a fragment of muscle or tendon,† or a large effusion of blood, has been found interposed between the fragments; as, were the interval small, pressure could scarcely fail to cause absorption of the intervening soft tissue. In one singular instance, mentioned by Berard, a fractured clavicle united by two bridges of bone, enclosing the ossified subclavius.

The most constant cause of non-union is undoubtedly motion. Norris was able to trace this cause for twenty-two out of forty-four cases, and suspected it in others. Amesbury goes much farther. He maintains that it is the cause in almost all cases, and that it is due generally to the inadequacy of the ordinary apparatus. That this is an exaggeration is shown by the facility with which most fractures unite under ordinary, or even bad, treatment; by the rarity of non-union in the ribs and clavicle, or after double or compound fractures; and by the occasional reabsorption of the callus from fevers. To prevent union, the motion must be considerable and long continued. To the influence of certain powerful muscles, as the deltoid and psoas, is due the frequency of non-union in the humerus and femur.

Numerous measures have been devised for the cure of pseudarthroses. But, as the distinction between the delay and arrest of the process of union is in all cases doubtful, it is only after the failure of the milder methods that recourse to operation is justifiable. For practical purposes, indeed, the failure of all means short of operation may be regarded as the only absolute proof of such arrest.

The indications for treatment are four. 1st. To remove all local impediments, as foreign bodies, dead bone, and disease of the bone or soft parts. 2d. To improve the general health. 3d. To ensure the primary conditions of union, immobility and contact of the fragments. 4th. To excite, by artificial means, the suspended reparative action between and around the fragments.

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* Art. 'Fracture' in *Dict. de Méd.* sup. cit.

† S. Cooper, in *Dict. of Pract. Surg.* 1838, p. 551; and Stanley, in *Lancet* for 1854, vol. i.

The various constitutional cachexiæ must of course be met by their own special remedies. Change of air and scene, and improved living, is often all-sufficient treatment. In cases of debility, with excessive secretion of phosphates, as in Penel's case, mineral acids and tonics are required. Mercury, given to salivation, as first recommended by Fleury, even in cases where there is no suspicion of syphilis, has been much vaunted by some, and has occasionally been of service where other means have failed.* It has, however, repeatedly been found useless, and can be tried with safety only on plethoric patients.

The local means which have been adopted to answer the remaining indications are: 1. Rest and pressure. 2. External stimulants. 3. Friction. 4. Setons. 5. Acupuncture. 6. Galvanism. 7. Subcutaneous incision. 8. Perforation of the bone. 9. Resection, with or without ligature of the fragments. 10. Resection, with preservation of the periosteum. 11. Rasping the ends of the bone. 12. Cauterisation. 13. Stimulant injection. 14. Dieffenbach's operation.

Amesbury, following out his own doctrine, maintains that, except in the rare cases of preternatural joint, or when union is prevented by the presence of a foreign body or diseased bone, rest and pressure is almost invariably sufficient for the cure. By this method he has succeeded with fractures of from ten weeks to sixteen months' standing, even after setons and other measures had failed. Although others have not found this treatment so universally successful, it must of course, in the great majority of cases, take precedence of any other. It is specially applicable in those cases where non-union depends on motion or malposition, or on deficient local action from general anæmia, without atrophy of the fragments, and in all cases attended with thickening and tenderness at the seat of fracture.

If the limb be healthy, Amesbury's or some other form of immovable apparatus is the most efficacious. But if it be œdematous, or inflamed, or atrophied, movable splints are better. There are cases, especially in children, in which it is scarcely possible to obtain perfect immobility except by including in the apparatus the adjoining part of the trunk. Lateral pressure may be made by bandage and compresses; longitudinal by crutched splints in the upper extremity, by straps and collars in the lower.*

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* Hammick, op. cit.; and B. Cooper, in *Guy's Hosp. Reports*, 1837, p. 399.

In most cases it is not enough to keep the fragments in close contact. A certain amount of stimulus is requisite. For this purpose, Amesbury directs that the pressure be sufficiently great to produce pain in the course of a few days. The duration of treatment in his cases varied from three to ten weeks. In others, where rest alone has been relied on, four or five months have sometimes been found necessary.†

The efficacy of all local measures appears to depend, not so much on the irritation of the bone itself, as on the action which they arouse in the soft parts surrounding and connecting the fragments. It has happened in cases of tardy union, that an accidental bruise‡ or attack of erysipelas§ has hastened the process. It is on this principle that external applications are recommended. Stimulant lotions,‖ blisters,¶ iodine,** galvanism, issues, and cautery, have all been used with occasional success. If the limb is atrophied, and in the condition of local scurvy, exposure to air and light, friction, stimulant embrocations and galvanism are of the greatest service. Under other circumstances, the advantages of any of these external applications are confined to cases of simply tardy union in superficial bones. In these they are of undoubted benefit, but only when used at an early period, within eight or ten weeks after the fracture. The most tested, and probably the most efficacious, are blisters. Walker employed a succession of small ones; Velpeau, with equal success, or nearly so, a few large ones. Malgaigne suggests the substitution of sinapism as being more rapid, but does not appear to have put his suggestion to the proof. Birch†† found galvanism

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[*] See Amesbury's *Treatise* for detailed description of his apparatus, as applied to different limbs.

[†] Bonnet, *Gaz. Méd.*, Sept. 1839.

[‡] Wardrop, *Med.-Chir. Trans.* vol. v. sup. cit.

[§] Seerig, *De Pseudarthrosi de fracturâ proficiscente*, 1838.

[‖] Cloquet, in art. sup. cit., and Jobert. See Fleury's Memoir, *Quelques considérations sur les causes qui peuvent retarder*, &c. Archives de Médecine, août 1837.

[¶] Walker, *Lond. Med. and Phys. Journ.* xxxii. p. 470; Brodie, sup. cit.; and Velpeau, *Méd. Opér.*

[**] Buchanan, *Essay on a new Mode of Treatment for Diseased Joints and the Non-union of Fractures*, London, 1828; also Crosse and Blackwell, see Norris.

[††] In Steevens's translation of Boyer's work.

of service in two cases. Mott* tried it without benefit. Twice, too, a caustic-potash issue was employed with success by Hartshorne.†

Friction of the fragments is somewhat more stimulating than mere pressure. There are two modes of effecting it. The usual method is manual; rubbing the fragments against one another for some minutes, till a degree of uneasiness or even pain is produced. It may be repeated, if necessary, daily, till the part becomes tender and painful. It is intended to break down the connecting bands, and even roughen the surfaces of the bone. The other method, applicable only to the lower extremity, recommended first by White,‡ and afterwards adopted by Hunter, Champion, and many others,§ is to envelop the limb in a firm apparatus, and direct the patient to walk on it. In White's case, a large abscess formed in the thigh; this, however, did not prevent a favourable result, and is the only instance in which positive harm has resulted from the treatment. In another case the apparatus could not be borne.‖ Friction should always be tried, as supplementary to rest and pressure, before stronger measures are adopted. Its greatest triumphs are in cases of general anæmia, when from the first there has been little or no action, and the fragments are loose and movable, as in a scrofulous lad under the care of Sir S. Hammick. It is of course contra-indicated by the presence of inflammation.

Dr. Physick¶ was the first to attempt the cure of non-union by passing a seton between the fragments; though the first idea of it has been ascribed to Winslow. Since that time setons have been extensively employed, with a considerable share of success. Of the 150 cases tabulated by Norris, they were tried at some period of the treatment in seventy-two, in only twenty-eight of which they failed. Although Dr. Physick, according to his nephew's report,** generally succeeded by this plan in the upper extremity, and failed in the lower, subsequent experience has shown that it is specially adapted to fractures of the leg and forearm, and smaller bones. In these, failure is rare, Norris's table pointing to only one out of twenty-two cases. Whereas in the humerus and femur, the unsuccessful cases slightly preponderate. The duration of the treatment has varied greatly. Physick allowed the seton to remain four or five months, or even more; in fact, till union was either completed or hopeless. Earle left it for seven weeks;* Wardrop recommends two or three weeks; and Liston eight or ten days.† No arbitrary time can be fixed; but the object being to excite local action, and not to exhaust the powers by prolonged suppuration, which, indeed, is more likely (as in compound fractures) to retard than to promote union, besides increasing the risk of erysipelas, the seton should be removed as soon as there is considerable solidification in the neighbourhood. If there is no suppuration, so much the better. Adams mentions a case in which the seton was left in only four days, and was yet successful.‡ Its prolonged use does, indeed, appear to have impeded union in some instances, especially in the large bones.§ Liston records a case where it was left in the humerus for thirteen months:‖ a useless arm was the result.

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* *Med. and Surg. Reg.* part ii. p. 375.

† *Philad. Med. Recorder*, April 1826.

‡ *Cases in Surgery*, 1770, p. 75.

§ Velpeau, *Méd. Opér.* 2d ed. t. ii. p. 583.

‖ Sue, in Desault's *Clinique*, t. ii. p. 312.

¶ *New-York Med. Repository*, vol. i. 1804.

** Brodie, loc. cit.

It appears from the statistics to be a matter of perfect indifference whether the bone is reached by previous incision or not. It is simply a question of convenience. Weinhold recommended a wedge-shaped seton, as being, in his opinion, both safer and more efficacious.¶ Its effect may also be increased by smearing it with red precipitate or other irritant,** or by combining its use with that of friction, or even with some more serious operation.

The treatment by seton is not altogether free from risk. Twice it has been fatal. Many cases have been endangered by attacks of erysipelas or profuse suppuration. In Wardrop's case†† there was severe hæmorrhage from a wounded artery. In another, under Stansfield,‡‡ the seton gave rise to intense pain. Its use is precluded by great separation or excessive mal-position of the fragments, by the absence of uniting medium between them, by irregular deposits of bone, by the proximity of a joint, or by the antiquity of the fracture. In most other cases, especially in the leg or forearm, it is admissible.

In two cases in the humerus, and one in the forearm, in which he was unable to introduce a seton between the fragments, Oppenheim§§ passed two, one on either side, so as to create irritation in their immediate neighbourhood. He recommends the operation as more effectual than the ordinary mode, and Malgaigne considers it more rational. It is, at any rate, equally successful.

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* *Med.-Chir. Trans.* vol. xii. 1823, p. 190.

† *Practical Surgery*, 4th ed. 1846, p. 99.

‡ *Med. Times and Gaz.*, 1851, vol. ii. p. 391.

§ Malgaigne, p. 311, sup. cit.

‖ Supra cit. p. 100.

¶ *Hufeland's Journal*, May 1826.

** Weinhold, ut supra; and Liston, in *Lancet*, April 30, 1836.

†† Supra cit.

‡‡ Mentioned by Brodie.

§§ *Ueber die Behandlungsweisen der Pseudarthrosen*, &c. in *Hamb. Zeitschrift*, vol. v. pt. 1.

Analogous to setons are ligatures passed round the tissue connecting the fragments, and gradually tightened till they completely cut through it, thus stimulating successively different portions. Sommé[*] used a silver wire for the purpose, and Seerig[†] a waxed thread.

In one case, in the lower fourth of the femur, Malgaigne[‡] endeavoured to pass acupuncture needles between the fragments; but they were so close that, although he thrust in thirty-six directions, he was not able to introduce even one needle. Wiesel[§] was more successful in the forearm. He operated first on the ulna, and afterwards on the radius. The needles completely traversed the false joint, and were left in for six days, till they caused pain and swelling. The cure was complete in six weeks.

By means of needles a current of galvanism has been passed through the connecting ligament by Brennan[‖] and Lente[¶] of New York. Both these authors considered it of service. It was tried by Square[**] without effect.

C. Bell[††] proposed to wound and irritate the ends of the bone by the subcutaneous introduction of a pointed instrument; but he had no opportunity of carrying out his idea. More recently, M. Blandin,[‡‡] having divided the connecting tissue with a tendon-knife, scraped the fragments with its sharp edge; but erysipelas and abscess were the sole results. A great improvement in this operation was effected by Miller,[§§] who confines himself to the laceration and irritation of the connecting tissue, by passing through it, in various directions, a double-edged bistoury or tendon-knife. Brainard[‖‖] employs for this purpose an awl-shaped perforator; and in cases of overlapping he perforates the fragments themselves in two or three places, making, however, only one small wound in the skin. The treatment has met with great success, and is applicable to most cases, but especially where the connecting tissue is long and loose. Miller suggests that it might be advantageously combined with galvanism.

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[*] *Med.-Chir. Trans.* vol. xvi. part 1, 1830, p. 36.

[†] *Arch. Gén. de Méd.*, Jan. 1839, p. 105.

[‡] *Traité des Frac.*, 1847, p. 307.

[§] *Journ. de Chirurgie*, 1844, p. 85.

[‖] *Monthly Journ. Med. Sci.*, Feb. 1848.

[¶] *New-York Journ. Med.*, Nov. 1850.

[**] *Med. Times*, 1851, vol. ii. p. 300.

[††] *Oper. Surg.* 2d ed. 1814, vol. ii. p. 326.

[‡‡] *Gaz. des Hôpitaux*, 1844, pp. 557, 569.

[§§] Miller's *Principles of Surgery*, 2d ed., 1850.

[‖‖] *Trans. Amer. Med. Assoc.* vol. vii. 1854; and in Hamilton *on Fractures*, 1860.

Resection, scraping, and cauterisation aim at more than the preceding operations. Their object, besides irritation, is to remove the effete and indolent tissue covering the ends of the fragments, and to place them in the condition of a recent compound fracture.

Resection of the fragments was first put in practice by White.* He operated with success on the humerus and tibia. In the latter case, in consequence of the difficulty and danger of reaching the lower fragment, he excised the end of the upper one alone, irritating the other by scraping the periosteum, and destroying the soft tissue which prevented their approximation by butter of antimony. This difficulty is one of frequent occurrence in the performance of this operation; and Dupuytren,† on the strength of two successful cases, suggested that all the efficacy of the operation may be obtained by the resection of one fragment, and rasping the other. For many years resection was regarded with much favour. Of Norris's 150 cases, it was performed, on one or both fragments, in no less than sixty-four; in thirty-seven successfully. In the leg it never failed; rarely in the forearm. But with the humerus and femur the results were far otherwise. Of twenty-seven operations on the humerus, eleven only were followed by union, two were fatal. Of seventeen on the femur, ten were successful, but four fatal. On these bones, indeed, the operation is encompassed with difficulties and dangers. In one case it lasted two hours;‡ in another,§ after an hour's duration, it was immediately followed by fatal convulsions. Rowlands‖ was so struck with the difficulties he had to encounter in the thigh, that he admits he should hesitate to recommend it. In fact, for the larger bones its dangers are so conspicuous, that it is now universally abandoned. But in others, especially the superficial bones, it is still occasionally adopted. Where there is a true diarthrodial joint, especially if the ends of the fragments are enlarged, or rough with deposit, it is the best, perhaps the only admissible, operation. Next to these, it is most applicable to cases of long standing, or in which the fragments are loose and widely separated, or greatly overlapping. It is absolutely precluded by the neighbourhood of a joint.

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* *Cases in Surgery, with Remarks*, Lond. 1770.

† *Resection de la Machoire inf.*, *Leç. Orales*, t. iv. p. 658.

‡ Walb, *Amer. Journ. Med. Sci.* xvii. p. 46.

§ Vallet, *Thèse inaug.*, Strasb. 1817; and in Velpeau's *Méd. Opérat.* t. ii.

‖ *Med.-Chir. Trans.* vol. ii. 1813.

In some instances there has been great difficulty in keeping the fragments in contact or at rest after the operation. Three methods have been devised for the purpose. 1st. M. Roux[*] locked the point of one fragment into the medullary canal of the other; the operation failed in consequence of a fall. 2d. The fragments have been cut obliquely, so as to present a larger surface for mutual contact and support, and to admit of lateral pressure. This mode of section produces less shortening than the transverse.[†] 3d. The third method is suture, either by waxed thread, used unsuccessfully by Flaubert; or, better, by silver-wire, which was first employed by Horeau,[‡] afterwards, with success, by Rogers, Mott, Laugier, and others, on the humerus, femur, and radius.[§] This practice, though denounced by Norris, who states that he has known an instance in which it was fatal, appears to increase the efficacy, but not the danger, of resection. In an operation on the lower jaw, in which this mode of retention is essential, Dupuytren passed the connecting wire round the teeth.[‖]

Jordan ascribes the failure of resection to the removal of the periosteum. He, therefore, by means of some blunt instrument, as the handle of a scalpel, dissects this membrane from the portions of bone which he is about to remove, and leaves the two empty pouches passed one within the other, and, in some cases, connected by suture, to form new bone. The suggestion is undoubtedly theoretically sound. Its practical value remains, however, to be proved. In two of the three cases which Jordan records, it failed of success; and he admits its failure in the hands of M. Sedillot.[¶]

In an ununited fracture of the humerus Hunter effected a cure by opening the synovial cavity, and irritating its interior with a spatula.[**] This is the only case of the kind on record; but scraping the fragments, originally suggested by White, has been occasionally adopted independently of resection. The results are not encouraging. Failure has been more frequent than success, and twice the operation has been fatal.* Brodie plugged the wound with lint, and failed; but his proceeding has been successfully imitated by Davies.†

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[*] Mentioned by Berard in art. 'Fracture,' sup. cit.

[†] Langier, *Mém. read to Acad. des Sciences*, April 1855.

[‡] *Journ. de Méd. Clin. et Phar.* vol. x. p. 195.

[§] Laloy, *De la Suture des Os*, &c., *Thèse inaug.*, Paris, 1839.

[‖] *Resection de la Machoire inf.*, in *Leç. Or.* t. iv. p. 658.

[¶] *Traitement des Pseudarthroses par l'autoplastie périostique*, Jos. Jordan, Paris, 1860.

[**] Referred to by Brodie on the authority of Home. See also Hunter's *Works*, Palmer's ed. 1835, vol. i. p. 504.

Cauterisation is a less dangerous operation, though not often employed. Different caustics have been used; caustic potash, which is the best, by Cline,‡ Earle,§ and others; nitric acid by Ollenroth;‖ chloride of antimony by White and Weilinger;¶ nitrate of silver by Kirkbride.** In one of Earle's cases and in White's, there was a slight exfoliation of bone; but this is not usual. Cauterisation is most applicable to old cases, when the fragments are covered with fibro-cartilage, or with a genuine false joint.

A mild species of actual cautery was used by Mayor†† on the femur. He pressed several times between the fragments a steel probe heated in boiling water. It produced profuse suppuration and union. The actual cautery was once used by Petit.

In a case of non-union of the humerus, in which there was a fistulous opening, Hulse‡‡ found the daily injection of a stimulating liquid of service, both to hasten the separation of the dead bone and stimulate the growth of new.

In 1845 Dieffenbach introduced an operation which bids fair, in most cases, to supersede the severer measures just noticed. Taking advantage of the fact pointed out by Duhamel and Flourens, that inert foreign bodies lodged in bone become surrounded by abundant osseous deposit, he drills three or four holes, penetrating as far as the medullary canal, near the end of each fragment, into which he forcibly drives ivory pegs. The pegs, projecting from the bone, are left from ten to twelve days or more; that is, till their presence has given rise to considerable swelling. Union is completed in from ten to twelve weeks. Dieffenbach himself appears to have met with great success from this operation, even on the humerus and femur.* In England it has been performed successfully on the femur, tibia, humerus, and ulna.† It has, however, met with reverses. The first time it was tried, by Square‡ of Plymouth on the femur, it utterly failed. The case, however, was a most unfavourable one, and eventually the limb had to be amputated. Bowman§ also failed in the leg, in a case equally unfavourable from excessive deformity. The operation has been followed, in different cases, by fever, erysipelas, hæmorrhage, and profuse suppuration, but does not appear to have been fatal, offering, in this respect, a favourable contrast to resection, due probably to the circumstance that it does not expose the end of the medullary canal. In one case‖ the operation on the femur was followed by union, leaving, however, a sinus, and succeeded, some weeks later, by erythema, profuse suppuration and hectic, necessitating amputation.

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* In one of these a seton was used also. See Malgaigne's *Traité*, sup. cit. p. 317.

† *Lancet* for Feb. 5, 1859.

‡ South's *Transl. of Chelius' Surgery*, vol. i. p. 591.

§ *Med.-Chir. Trans.* vol. xii. p. 190.

‖ Bernstein, *Ueber Verrenkungen*, &c., p. 280.

¶ *Rust's Magazin*, vol. xxxiv. p. 330.

** *Amer. Journ. of Med. Sci.*, Feb. 1835.

†† *Nouveau Système de Déligation*, &c., Geneva, 1832.

‡‡ *Amer. Journ. of Med. Sci.*, Feb. 1834.

In an operation on the femur, Stanley connected the fragments by a silver wire, in addition to inserting the pegs.¶ The result is not given.

The above operations are practically divisible into two classes: those which are followed by suppuration, and those which are not. The latter must, of course, in all cases in which they are likely to be sufficient, take precedence. The circumstances by which the selection must be guided are the situation and condition of the false joint, and the length of time that has elapsed since the fracture. Special indications have been noticed under the individual operations. Apart from them, where rest and friction, aided, if possible, by external stimulants, have been found insufficient for the cure, Miller's or Brainard's operation deserves the first trial; next to that, some form of seton; and, as a last measure, Dieffenbach's operation. In the humerus and femur it will generally be advisable to omit the seton, and pass at once to Dieffenbach's plan. If the fragments are covered by a very dense tissue, it may be removed, as an accessory measure, either by the knife or caustic.

It is to be observed that no severe operation will be justifiable unless the inconvenience resulting from the non-union is considerable. In some cases, as in the ribs, it is of no practical consequence. In others the new joint supersedes an old one. This has happened after a fracture two inches above the elbow,* and frequently in the neck of the femur. In others, the slight inconvenience is easily and abundantly remedied by an artificial support. Larrey, indeed, recommends this course to be adopted whenever the simple means of cure fail.† In a few cases, where a lost portion of the tibia has not been restored, as in three witnessed by Sir A. Cooper, its place has to a great extent been supplied by a large increase of the fibula.

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* Dr. Bushnau's report in *Med. Times and Gazette*, vol. xv., 1847, p. 298.

† See *Lancet*, 1851, vol. ii. p. 344; 1852, vol. ii. pp. 152, 154; 1855, vol. ii. p. 279: also *British Med. Journ.*, 1859, p. 885.

‡ *Med. Times and Gazette*, 1851, vol. ii. p. 300.

§ *Lancet*, 1852, vol. ii. p. 153.

‖ *Edin. Monthly Journ.*, March 1854.

¶ Stanley, *Lancet*, 1854, vol. i.

There are a few cases in which, in consequence either of hectic, or of the great encumbrance of a useless limb, on which all operations have failed, amputation is the only resource.

Diseased and deformed union. The new bone is of course liable to all the diseases of bone. The two most frequent and most troublesome are long-continued pain, analogous to the neuralgia of cicatrices in soft parts; and excessive exuberance, the result of osteitis.‡

There are three species of deformity resulting from mal-union: 1st. Junction with permanent displacement, either angular, or rotatory, or shortening. 2d. Union of two contiguous bones. 3d. Projection of one of the fragments.

For the removal of the first kind of deformity four methods have been devised: reduction by means of extension and compression, refracture, section, and resection.

Extension is made, as in the original reduction of fractures, by the hand, or by the assistance of lacs and pulleys, or, gradually, by means of splints. Compression, too, may be applied gradually or suddenly. Gradual compression is made by splints or special apparatus. A splint may be placed opposite the concavity of the angle, and the bone drawn towards it; or it may be fixed to one fragment on the convex side, acting as a lever to which the other is to be drawn; or the projecting angle may be pressed between two opposing splints. The bandages must be repeatedly tightened. Special apparatus of curved splints, straps, and tourniquet-pads have been used, but are rarely, if ever, necessary.§

The apparatus, combining pressure and extension, must be worn for from twenty-one to twenty-eight, or even forty days. Sometimes it is sufficient, after two or three weeks, to continue extension alone. By this treatment deformity has been remedied in numerous fractures: in some of twenty-five, twenty-nine, fifty-nine days, or even as much as four or five months' standing. Dupuytren thinks that the union will not yield to extension beyond the sixtieth day; but pressure may be of use much later.[*]

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* *Med. Times and Gaz.* 1851, vol. ii. p. 221.

† *Clin. Chirurg.* vol. iii. p. 461.

‡ *Des Accidents consécutifs aux Fractures*, par M. Guyot, in *Arch. de Méd.*, Feb. 1836.

§ Jacquemin, *Thèse inaug.* Paris, 1822.

Sudden forced compression has been sometimes employed; but, except in those cases where it has been used at a comparatively early period, it appears to produce a species of partial fracture. Where reduction cannot be obtained at the first trial, it may be repeated in two or three days.[†]

Refracture is effected gradually, during extension, pressure being made either by the hands or knee, or, in difficult cases, by a screw-press.[‡] Skey manages it readily by leaning the weight of his body on the end of the limb, projecting beyond the edge of a board or bed. The fracture is facilitated by bending the limb alternately in different directions, and, when there is only one bone, by rotation. The old practice of breaking it by a hammer, or by sudden pressure across a stick, is justly discarded.

The time during which a united bone admits of refracture varies greatly, even to the extent of many weeks. It depends on the age and health of the patient, the extent of uniting surface, the position of the fragments; in fact, on all those circumstances which influence the rapidity and perfection of the healing process. The cases of deformity for which the operation is required are the very cases in which union is ordinarily most protracted; and long after it is sufficiently firm to admit of free use of the limb, it may be dissolved by force without difficulty. Moreover, in young subjects, in whom these deformities are most frequent, refracture is attended with the least difficulty. Œsterlen, however, did not attempt it in any case beyond the twenty-fourth week;[§] and Bosch, in spite of the power of his screw, recommended six or six and a half months as the extreme limit. But Skey operated once on the leg, in a boy æt. 15, thirteen months after the fracture.[‖] In that case he found it necessary to divide the tendo Achillis before he was able to make extension, and even then the limb remained shortened to the extent of three-quarters of an inch.

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[*] *De la Formation du Cal: Moyens de remédier au cal vicieux ou difforme, Leç. Orales*, t. iv. art. 5, p. 130.

[†] A. Thierry, *Du Redressement des Os fracturés, Exp.* Nov. 1841.

[‡] As used by Bosch, of Augsburg, described by Œsterlen.

[§] *Sur la Rupture du Cal, ou Méthode sur de rompre les Os mal reduits*, par J. F. Œsterlen, traduit de l'Allemagne par J. C. Maurer, Paris, 1828.

[‖] *Cases of Refracture of Bone ; Med.-Chir. Trans.* vol. xlii. p. 23.

Four objections have been raised to this operation. 1st. The danger of breaking the bone in the wrong place. Œsterlen and Skey, however, show that this danger is chimerical, the new bone being for many months more spongy and more fragile than the old. This dreaded accident has never happened; and, moreover, accidental refracture, which has taken place in some cases after two or three years, is always in the same place as the first, and the same has always occurred in experiments on animals. 2d. The fear of inflammation and abscess, in consequence of laceration of the periosteum and soft parts. But all such accidents have been safely overcome in the first fracture, when they were necessarily more severe. Skey refers to a case in which, without effecting his purpose, he had recourse to considerable violence; the only evil effects of which were slight bruising and stiffness, which passed off in two or three days. 3d. The separation of the fragments by an interval which could not be filled by bone. The cases are very few, however, to which this objection could apply, and even in them considerable amelioration of the deformity might be effected. 4th. The fear that, in cases of overlapping, the cicatrised ends of the fragments will be incapable of uniting. This fear, however, is unsupported by facts; the deformity is not commonly accompanied by deficiency of healing power; and in many cases the new fracture has appeared to unite even more readily than the old.

The operation has not always been free from danger. Cases fatal from its violence are recorded by Guy de Chauliac, Morgagni,* and Laugier.† Of course it is justifiable only when it is indispensable to the utility of the limb, when it can be undertaken without difficulty or danger, and the deformity was attributable to causes which can be avoided in the treatment of the second fracture, and only after all practicable means of reduction by extension and compression have been tried without success. With these restrictions, it may be resorted to, in the upper extremity, when shortening of the forearm is accompanied by loss of muscular power and inability to rotate; in the lower extremity, for extreme lameness, either from shortening or angularity; and, in either limb, for deformity accompanied by severe permanent pain, the result of pressure or displacement of nerves, and not amenable to other treatment.

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* *De Sed. et Causis Morb.* epist. lvi.

† *Des Cals difformes et des Opérations qu'ils réclament; Thèse du Conc.* 1841, p. 62.

If the union is too solid to admit of rupture, it may be divided by the saw. This has been done more than once; but only in one case, in which Key and A. Cooper operated on the tibia, was it justifiable.* Resection also of one or both fragments has been rarely, and then unnecessarily, resorted to.† M. Clemot removed an angular piece of bone from a deformed femur in an infant of forty days old.‡

Union of contiguous bones may take place in the forearm, the leg, or between the ribs. In the leg it is of course unimportant; and in the ribs, though an impediment to free respiration, it cannot be touched. In the forearm it might be remedied by rupture or section; but it does not appear that more than one instance of such an operation is recorded.§

The projecting point of one of the fragments may be the source of much irritation and inconvenience. Generally such projections are removed by absorption; but occasionally it is not so. They may in that case be removed by the saw or nippers. A few operations of the kind are mentioned by Velpeau,|| Dunn,¶ and others.

THOMAS KING HORNIDGE.

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* *Gazette Méd.* 1839, p. 366.

† By Lemercier, Riecke, vide Œsterlen, sup. cit. pp. 124 and 126; and Portal, *Gaz. Méd.* 1841, p. 601.

‡ Clemot, *Mém. sur la Resection du Fémur, Acad. de Méd.* 1836.

§ By Gardeil; quoted in Malgaigne's work, sup. cit. p. 342.

|| *Méd. Opér.* 2d ed. t. ii. p. 599.

¶ *Med.-Chir. Trans.* vol. xii. p. 167.

DISLOCATIONS.

THE term "dislocation" is etymologically equivalent merely to "displacement;" but in surgery the use of the word has been restricted to the displacement of one articular surface of bone from another;* and it would perhaps be more convenient still further to narrow the meaning of the term, so that it should include only such of these displacements as are caused by violence. This restriction, however, has not yet been made; hence dislocations are divided into three classes — congenital, pathological, and traumatic. The first are malformations, which, if they are to be treated at all, must be attacked in early life. Their consideration is therefore deferred to the section on the SURGERY OF CHILDHOOD. The second are symptomatic of various diseases of the joints, in which the displacement of the articular surfaces, though of the highest practical importance, is pathologically non-essential. They will be found discussed in the essay on DISEASES OF THE JOINTS. The third only form our present subject.

A traumatic dislocation, then, is a forcible separation of the articular surfaces of two or more bones. This is effected by the rupture or stretching of their ligaments, and may be *partial*, *i. e.* when parts of the articular surfaces remain in contact with one another, though not the parts naturally opposed; or *complete*, when the surfaces are not in contact by any part. Another classification of dislocations which it is necessary to dwell upon is, into *simple*, in which the dislocated bone is not exposed to the air; and *compound*, where there is a wound communicating with the injured joint.

The various special dislocations, *e. g.* of the hip, shoulder, &c., are described further on, with the injuries of the regions in which they severally occur; it is, therefore, only necessary here to state the general principles applicable to the pathology and treatment of

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* Occasionally, it is true, the term 'dislocation' is applied to the displacement of soft parts. Thus we talk of 'dislocation of the crystalline lens,' 'dislocation of the testicle into the perinæum,' 'dislocations of tendons from their grooves,' &c. This use of the word, however, can hardly create ambiguity.

Traumatic Dislocation.* Complete dislocations will be first spoken of, as affording the most intelligible and perfect examples of the injury; and the consideration of compound dislocations will be reserved till the principles which guide Surgeons in the treatment of the simple forms of injury have been described.

Causes. The causes of dislocation, as of fracture, are twofold: external violence, and muscular action. The latter, however, is, in the healthy state of parts, very rarely the cause of dislocation; while (as above shown, p. 756) fractures from this cause are less uncommon. Many instances, however, have been put on record, in which the humerus has been dislocated by the action of the muscles only; and of this accident the present writer saw once an example in the case of a patient who was lying in bed on account of another injury. In making some sudden movement of his right arm, the precise nature of which he could not afterwards explain, the humerus slipped out of the socket. No difficulty was experienced in reducing it. In this patient the bone had never been dislocated before; but in cases of old dislocation, especially when the original treatment has not been sufficiently prolonged, the injury is very often reproduced by mere muscular action, and then the bone is just as easily reduced. Many persons in whom the shoulder is so affected, have learnt to reduce the dislocation for themselves, by reaching over a gate, taking hold of one of the lower bars, and hanging in this position, when the mere weight of the body is sufficient to restore the parts to their place. There is also one dislocation, that of the lower jaw, which is almost always produced by muscular action; and it is the usual cause of dislocation of the patella.

Much has been said by systematic writers about the share which the muscles take in the production of the common dislocations from external violence, *e. g.* those of the hip and shoulder. There is, however, little practical importance in the question, though it is interesting physiologically, from its application to animal mechanics. It is not probable that the muscles have any other influence in producing most dislocations than that they sometimes fix the bone on which they act in positions in which the external force acts advantageously upon it. But since, as M. Malgaigne observes, most dislocations can be produced in the dead body as easily as in the living, it is clear that the action of muscles is a very unimportant element in such accidents.

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* For the sake of simplicity and to avoid repetition, the word 'traumatic' will be dropped in the sequel; but all that follows must be understood as spoken only of that form of dislocation.

A less doubtful effect of muscular action is the change which is often produced in the position of the displaced bone during the first few days after the accident; so that a bone which has been thrown into a certain position at the time of the injury may afterwards be found in another place. Thus the head of the femur is often drawn from the dorsum ilii into the sciatic notch; and the reverse of this sometimes occurs. Such dislocations are sometimes called consecutive. The action of the muscles is aided perhaps, in some cases, by the weight of the limb.

Symptoms. A complete dislocation is, in typical cases, attended with such very distinct symptoms, that when these are fairly detailed upon paper the reader is tempted to say that the injury is unmistakable. Yet the great number of old unreduced dislocations which are still seen, even in patients who have been from the first under medical supervision, proves that, notwithstanding the elaborate care with which the symptoms of dislocation in general, and of each special injury in particular, have been described ever since the time of Astley Cooper, such mistakes cannot always be avoided, even by well-informed and careful men; and it is no doubt true that errors in diagnosis on this head will sometimes occur to the best Surgeons, in consequence of extreme depth of the parts, of great effusion and swelling over them, or of complication with other injuries; but with proper care such mistakes ought to be very seldom made even at the time of the accident, and attention to the subsequent progress of the case will always enable the Surgeon to correct his error while there is yet a fair prospect of easy reduction.

The general symptoms of dislocation are, sudden loss of motion, following an injury which (except when the joint has been formerly the seat of a similar lesion) is usually severe; loss of the natural shape of the parts, from changes in the relations of the muscles surrounding the joint, and the altered position of the bones; change in the length of the limb, which in the great majority of dislocations is shortened; loss of the power of voluntary motion, except to a limited extent and in certain directions; absence of crepitus when the limb is manipulated; and great interference with passive motion, especially to certain movements; while, on the other hand, other passive movements limited or impossible in the healthy body may be absolutely unimpeded, in consequence of the rupture of the ligaments which before restrained them. Other symptoms, accompanying peculiar dislocations, and depending on interference with the functions of viscera, nerves, or vessels pressed upon or lacerated by the displaced bone, may be present and may assist in diagnosis; but they need not be further alluded to in this place.

Pathological anatomy. In a complete dislocation, the injury is usually not confined to the bones and ligaments only, but involves more or less lesion of the surrounding parts. The articular capsule is usually widely lacerated, and the special ligaments of the joint torn in various degrees. In partial dislocation it seems probable that this feature may be absent, the capsular ligament being merely put on the stretch; but it must be confessed that our knowledge of these injuries is not as yet very perfect. Mr. Wormald has related a case* where a partial dislocation of the hip, with fracture of the acetabulum, appears to have been the original accident, and where the ligamentum teres remained untorn; and Mr. Soden's case of (supposed) partial dislocation of the humerus upwards from displacement of the long head of the biceps is well known;† but, from the length of time which has passed in most of these cases between the injury and death, it is impossible to form from them an opinion as to the usual condition of parts at the time of the accident. Even in cases of complete dislocation, however, we may admit the possibility of simple stretching of the capsular ligament, without rupture, though perhaps we might not be able to refer to any preparation or history which proves this beyond doubt. There is, however, a preparation (No. 868) in the Museum of the College of Surgeons, showing the dissection, by John Hunter, of a shoulder-joint three weeks after reduction of a dislocation, in which he believed that the capsular ligament had not been torn, but merely stretched or bruised. There was, however, some trace of injury to the membrane still perceptible; and it must be allowed to be possible that it might have been lacerated at the time of the accident, and afterwards have united. The case of dislocation of the bones of the foot from the astragalus, reported by Mr. Pollock,‡ shows the extent to which ligaments may be stretched without absolute rupture. The os calcis was so movable on the astragalus that the sole of the foot could be turned vertically inwards; yet the interosseous ligament, though stretched, was not completely ruptured.

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* *Medical Gazette*, vol. xix.

† *Med.-Chir. Trans.* vol. xxiv. p. 212.

‡ *Med.-Chir. Trans.* vol. xlii. p. 43.

Besides the injury to the ligaments, a variable amount of damage is frequently done to the surrounding muscles, which are torn away from their attachments, lacerated, or stretched, according to the nature and extent of the displacement. The great nerves in the neighbourhood (such as the circumflex in the shoulder) are often compressed or lacerated, and hence severe pain at the time of the accident, and paralysis afterwards of the parts supplied by those nerves, which is sometimes irremediable. The large vessels almost always, in simple dislocation, escape without injury;* but they are sometimes compressed by the displaced bone, so as to obstruct the circulation through the limb. Fracture of some of the processes surrounding the joint is a very common complication. In fact, in some joints (as the ankle) it is rare to find a pure specimen of dislocation. The only importance of this fact is, that in such cases more care should be taken to procure and maintain exact apposition.

Such are the immediate effects of a dislocation. If the bones be restored to their natural position, all these injuries are generally soon repaired. The ruptured capsule readily heals, the injured muscles and tendons regain, in a great measure, if not entirely, their former condition and their former strength, and even the nerves, if contused or lacerated, may slowly recover themselves. It may, indeed, happen, although it is not common, that the joint inflames after reduction, even under proper and judicious treatment; but this complication need not be further dwelt on here, as it must be treated on the same principles as any other case of articular inflammation after injury.

If the dislocation, on the contrary, have been neglected, or if it have been found necessary to abandon its treatment, further changes necessarily follow—changes not absolutely incompatible with the preservation of a certain amount of motion, but which yet render the condition of the limb very doubtful.

These changes, like almost all other morbid phenomena, are principally efforts after the repair of the injury. The chief of them all is the appearance of a *new joint.* The head of the dislocated bone forms for itself a cavity on the bone upon which it is thrown; a cavity which is caused partly perhaps by inflammatory softening and the removal of some of the original bone, but principally by deposit of new bone on the surface of the latter. These new cavities are found lined by a substance which to the naked eye closely resembles cartilage, but which, under the microscope, shows the structure of fibrous tissue. The original articular cavity at the same time gets filled up with a fibroid deposit, and the head of the bone is surrounded in its new position by a cyst or new articular capsule formed from the surrounding areolar tissue. At the same time the displaced bone may suffer various changes of form, from inflammatory softening and ulceration, by which its shape and size will be essentially altered. These observations apply almost entirely to joints resembling the ball and socket in which an articular head is dislocated on to a flat bone. In ginglymoid and arthrodial articulations the process of repair will be much less extensive, and therefore the resulting recovery of motion much less perfect. Sometimes, indeed, in small joints of this kind, such as those of the fingers, complete bony anchylosis may follow.*

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* A case was operated upon this year by Professor Goldsmith, of Louisville, in which the femur had been dislocated on to the brim of the pelvis, so as to lie under the femoral artery. It remained unreduced for two months, when a diffused aneurism was found to have been formed. The common iliac artery was tied. The patient died on the fifth day. The femoral and external iliac arteries were found perforated to the extent of an inch on the posterior external aspect; and the head of the femur lay in the cavity of the aneurism. *American Journal of the Medical Sciences*, July 1860, p. 30.

The consequences of an unreduced dislocation, however, are not limited to the bones which are displaced, since the altered position of the soft parts and the irritation set up, somewhat in the manner of a foreign body, by the displaced bone, materially impede the function of the muscles. The tendons may have been carried away from their points of attachment and united to some point which is partially or entirely immovable; or (as is often the case with the long tendon of the biceps) they may have been split longitudinally and thereby much weakened, although a part retains its natural connections. As a consequence of these injuries, and of the inflammation which follows them, adventitious formation of bone is sometimes found in the tendons and in the other fibrous structures around the joint; another particular in which the consequences of old dislocation resemble those of chronic rheumatic arthritis, and therefore a fresh difficulty in the diagnosis of the two affections.†

Various causes may combine to produce adhesions between the bones. The articular cartilages will in all probability be absorbed, either as a consequence of inflammation (*e. g.* when the head of the bone has been resting against a prominent process or the stump of a fracture),* or from the atrophy which removes parts whose function is lost. The very completeness of the reparative process may sometimes be the cause of permanent loss of function to the joint. Thus in a case of unreduced dislocation of the radius, preserved by the writer in the Museum of St. George's Hospital, the orbicular ligament is seen to have been carried away with the head of the radius, and is firmly united in this position by both its ends to the humerus as well as to the radius, thereby binding these bones firmly together, and entirely preventing rotation. The great tendons sometimes form bands of adhesion between the bones. This is again illustrated by a specimen of dislocated elbow in the same Museum, where the brachialis anticus, torn off the coronoid process, which is carried into the olecranon fossa, has become firmly united both to the trochlear surface of the humerus, and to the ulna below its original attachment, so as to form a kind of soft anchylosis between them.

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* Preparations showing this condition may be found in the Museum of St. Bartholomew's Hospital, series iii. nos. 57, 61.

† Specimens in which a deposit of new bone in tendons is believed to have followed dislocation may be found in the Museum of Guy's Hospital, nos. 1297^{50}, 1298^{50}.

It seems probable that in some cases the edges of the rent in the articular capsule may unite either partially or completely, so that the hole which admitted the passage of the bone out of the joint will no longer allow it to go back again.†

It is also noticed by Professor Hamilton‡ that the great vessels sometimes become adherent to the capsule or periosteum of the displaced bone, leading to the risk of fatal hæmorrhage, should forcible attempts be made to effect reduction.

Such are the principal effects of unreduced dislocation. Other pathological changes may doubtless be observed; but the scope of the present work does not admit of detailed notice of mere pathological curiosities, and the reader who desires to follow the subject more minutely must consult special treatises. The chief importance of the study of these changes is in order to know the time at which they occur, so that the justifiability or otherwise of attempts at reduction a given time after the accident may be determined. Alteration in the shape of the bones, either by widening of the articular cavity or absorption of the head of the bone, may render permanent and safe reduction hopeless;* or deposit of new bone on the dislocated head may render it too large to fit the cavity; or the presence of soft anchylosis between the bones (either as a consequence of inflammation or of the vicious union of ruptured ligaments or tendons) may render necessary for reduction a force greater than can safely be applied; or the original articular cavity may be filled up with lymph or with the remains of the old capsule; or the articular cartilages may have been absorbed, so that no healthy joint could be reproduced.†

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* *Med.-Chir. Trans.* vol. xli. p. 450.

† See a case related by Mr. Hilton, *Guy's Hospital Reports*, ser. ii. vol. v. p. 96; a preparation in the Museum of St. Bartholomew's Hospital, dissected three weeks after the accident (ser. iii. no. 20); also a case by Hamilton, *American Journal of the Medical Sciences*, Nov. 1837, p. 47 (quoted by Malgaigne, op. cit. p. 53).

‡ *On Fractures and Dislocations*, Philadelphia, 1860, p. 492.

So that, in determining the question of the justifiability of attempts at late reduction, it is material to know the period at which these changes occur. Unfortunately nothing is more difficult, since patients are not often kept under observation till this somewhat remote period after dislocation, and therefore the history of the case is rarely known. Most of the preparations in our museums are quite devoid of histories, and the greater part of them show the state of things at a time when all question of treatment must have long been abandoned. It is clear, however, that the formation of a false joint goes on with considerable rapidity. Thus in the case previously mentioned (p. 817, note), the patient died of another disease thirteen weeks after the accident; the only reduction possible still left the head of the bone external to the capsular ligament. Mr. Hilton says: "All these parts (viz. the head of the humerus; the remains of the original capsule, now interposed between it and the glenoid cavity; the fractured great tuberosity, and its attached muscles) were included by a thin new fibro-cellular capsular ligament, and the surfaces contributing to the formation of the new joint were all smooth, and covered, as it were, by a new adventitious synovial membrane." In M. Malgaigne's work‡ a case is cited in which similar changes were discovered eighteen days only after the accident. Several other interesting cases will be found in the same work; but the cases hitherto published are far too few to form a scientific foundation for any general conclusions.

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* Mr. Curling relates a case in *Med.-Chir. Trans.* vol. xx. p. 338, in which insecurity of reduction was occasioned by absorption of the glenoid cavity.

† The deposit of bone in the tendons probably does not take place till a time at which no prudent surgeon would think of endeavouring to reduce the dislocation.

‡ Op. cit. p. 52.

Diagnosis. On the subject of diagnosis hardly any thing need be said in this place. The only injuries with which dislocation can be confounded are, 1. simple contusions and sprains, and 2. fractures near the joint, or separation of epiphyses. The diagnosis in the first case is made by recognising the positive symptoms of a dislocation instead of the negative symptoms which imply its absence; and as to the second, the diagnosis between fracture and dislocation has been already discussed (see FRACTURES, p. 767). Separations of epiphyses are distinguished from dislocation by the following characters: 1. The former can only occur at ages at which the epiphyses are separate from their shafts; the latter at any age. 2. The former are, as a rule, easy to reduce, and difficult to retain; in the latter, as a rule, these conditions are reversed. 3. In the former, the points of bone immediately surrounding the joint preserve their normal relations; in the latter, these relations are variously altered. 4. The sensation perceived in the two injuries is somewhat different, that in the former bearing more or less resemblance to the crepitus felt in fracture, in proportion as the epiphysal cartilage is more or less thick. Perhaps it may be added, that an error in diagnosis would be rather mortifying to the surgeon than prejudicial to the patient, since the general indications are the same.

Treatment. When the diagnosis has been established, if the injury is recent and the patient is suffering much pain, reduction should be at once attempted—at least, this should be the rule in all joints except the hip, where it is perhaps better to wait until chloroform and some extending apparatus can be procured, in case either the one or the other should prove necessary; and in some of the smaller joints, when the patient does not suffer much, we may be guided by circumstances whether to attempt reduction immediately or put it off till some more convenient time and place. There is always a fair chance of reducing a recent dislocation, at any rate of any joint except the hip,* without any appliances or assistance; although, from peculiar complications, or from the great muscularity of the patient, failure may occur in almost any. The principles of reduction are very simple, and the various mathematical and anatomical refinements, with which the ingenuity of systematic writers has surrounded the subject, are never thought of in practice. The process is as follows: 1. The upper end of the limb must be fixed; 2. the lower end must be pulled in the most advantageous direction (reference being had to the insertion of muscles into it, and to the shape of the parts on which the displaced head is lying), until by this extension the limb has been restored to its proper length; and then, 3. the displaced bone or bones must be directed into the joint by manipulation or traction.

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* Perhaps in dislocation of the thumb it is also expedient to wait for chloroform and pulleys. Still, I have reduced this dislocation, and seen it reduced, by simple extension.

The second is the most difficult indication to fulfil. In the majority of recent and simple dislocations, all that is necessary is to know the anatomy of the parts, and the rules applicable to the special injury under treatment, which will be found in subsequent sections of this work, and to make manual extension in the manner indicated by those rules. But in more complicated and less recent cases something must be done to relax or subdue the muscles. It was formerly considered necessary for this purpose to reduce the powers of the system by venesection and tartar-emetic; but this treatment has now been entirely superseded by the discovery of chloroform. In no part of operative surgery has this great discovery made a more complete revolution than in the treatment of dislocation; so that what was frequently a most difficult, and always a very painful operation, has now become comparatively painless, and usually quite easy. The rule, therefore, in all dislocations which cannot be reduced by the first attempts which the Surgeon makes with his own unaided force, is to administer chloroform; having the necessary apparatus at hand for making forcible extension, if required. The only exceptions to this rule are, when, from concomitant disease or injury, chloroform is in the judgment of the Surgeon contra-indicated. But these reasons act also to contra-indicate all forcible attempts at reduction; for should the contra-indication be a diseased state of the heart,* this condition would also forbid to any one of ordinary prudence a forcible, prolonged, agitating, and painful operation; and if the complication of other injuries render it unadvisable to give chloroform, no objection exists to waiting until the effects of such injuries subside before attempting reduction.

In old times, the muscles used to be overcome by the prolonged

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* The reader will observe, that no opinion is here expressed on the correctness of the prevalent opinion that disease (whether valvular or degenerative) of the heart is an absolute contra-indication to the employment of anæsthetics.

traction of a number of men, or by various mechanical contrivances, some of them of the most ludicrous nature, which may be seen described in old books of surgery. For these paraphernalia a later age has substituted the *pulleys*, a most valuable machine, and one still indispensable to the treatment of dislocation, though less frequently called into play since the discovery of chloroform than it used to be.* It consists of a system of pulleys on a single string; an arrangement by which the force is multiplied by the number of the strings on the lower block. The pulleys are attached on one side to a staple driven into the wall, and on the other to a bandage of leather firmly bound to the limb, and usually to that segment of it which is dislocated, instead of to the one below, *e. g.* above the elbow in a dislocation of the shoulder rather than below. The limb above the dislocation is fixed, by means of another stout leather bandage, to a staple opposite the former. Having seen that the string of the pulleys runs freely, and that the bandages are all in their proper places, the Surgeon confides to one assistant (if he have two) the care of the upper bandage, to see that the patient's body does not get dragged out of place by the force which is to be applied, and to the other the string of the pulleys. The latter, having been made so tight that the upper bandage is visibly pulled upon, is then to be cautiously and gradually tightened, a small piece of the cord being pulled in at regular intervals. In France, an instrument called the dynamometer is attached to the pulleys, in order that the precise force used may be accurately measured. Meanwhile the Surgeon manipulates the head of the bone; and when it appears to him that the force has acted sufficiently upon it, *i. e.* when it has come opposite to the empty articular cavity, he gives the word to his assistant to drop the string of the pulleys; and then, without the loss of any time, directs the head of the bone into the articulation, either with his hands or with a lever of some kind passed below it. Should this attempt fail, it may be renewed, or the limb may be bandaged in the position which it has now assumed, and a fresh trial made on the next or some early day. It is frequently advisable in old dislocations, where the displaced bone has contracted adhesions, to limit the first extension to breaking down these bands, postponing all efforts at complete reduction till another opportunity. Reduction having been accomplished, the position of the joint must be maintained by bandages, or slings, for a certain period, which varies for each joint, and which is prescribed for each in subsequent sections. If this precaution is omitted, the head of the bone will almost certainly slip out of the lacerated opening in its articular capsule, and the dislocation be reproduced; or even where this does not take place, the motion of the joint will cause some amount of effusion, which will interfere with the proper union of its ligaments, and leave the joint permanently weak, and very liable to consecutive dislocation. Cases of this kind are very frequently seen, in which dislocation is reproduced by very trifling causes, and is as easily reduced, showing the laxity and weakness of all the parts surrounding the articulation. Hence it is important to keep the parts at rest during a sufficient time, though the opposite extreme must also be avoided, since too protracted inaction might cause troublesome or even permanent loss of motion from soft anchylosis.

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* Cases will occur when the pulleys are not at hand, and then the assistance of several men, to make extension and counter-extension, must be employed. Great care should be taken to make them pull together gradually and steadily. Or the following contrivance, described by Dr. Gilbert of Philadelphia (v. *Hamilton*, op. cit. p. 494), may be used. "Place the patient, and adjust the extending and counter-extending bands as for the pulleys; then procure an ordinary bed-cord or a wash-line; tie the ends together and again double it upon itself, pass it through the extending tapes or towels, doubling the whole once more; and fasten the distal end, consisting of four loops of rope, to a window-sill, door-sill, or staple, so that the cords are drawn moderately tight; finally, pass a stick through the centre of the double rope, then by revolving the stick as an axis, or double lever, the power is produced precisely as it should be in such cases, viz. slowly, steadily, and continuously."

Other instruments have been proposed for making forcible extension, such as Jarvis's adjuster, Bloxham's dislocation-tourniquet, &c.; but it has never occurred to me to see any case in which all the force that could be prudently applied to the limb was not easily obtained by the pulleys.

When reduction fails from any cause, much judgment and care are required to determine whether the attempt should be renewed or abandoned. On the one hand, the damage and discredit of leaving the patient to his fate will weigh powerfully in favour of perseverance; on the other, serious mischief has often resulted from too protracted and too violent attempts at reduction. Bones have been fractured, tendons ruptured, even the large vessels of a limb have been torn. Still more frequently the pressure of the bandages produces troublesome sloughing, which, when the limb is of small size, as the thumb, may even cause the loss of all its remaining usefulness.* The method of procedure which was adopted should be carefully reviewed, in order to see whether there was any fault in it; in which case there will be much encouragement for the trial of a better plan. If, however, no improvement can be suggested in this respect, then attention must be directed to the position of the limb, whether changed or not by the extension; to the nature of the dislocation; the state of the parts; and to the time which has elapsed since the accident. If the position of the displaced bone has been, though not entirely remedied, yet improved; if no injury has been done by the extension; if the dislocation is within a period at which reduction is commonly successful, and of a joint which offers no peculiar obstacles,—then the decision will be in favour of persevering; while in the opposite case the Surgeon will probably require the expressed wish of his patient (if a person of intelligence and with a full understanding of the question), and the assent of competent colleagues, before venturing on a step which involves certain risk, and offers only doubtful advantage.

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* Samuel Cooper (*First Lines of Surgery*, 7th ed. p. 705) gives the surgeons of St. George's Hospital, fifty years before his day, the credit of

If it be found necessary to abandon a case of dislocation, the patient may be comforted with the assurance that his limb, though it will never be as useful as before, may yet recover a good deal of motion; at least, this assurance may be given very confidently in the case of such joints as the hip and shoulder. The ultimate result of such cases is, that the displaced bone forms for itself a new socket, in which a considerable amount of motion is allowed. The result in ginglymoid joints is usually less favourable; still, they may do well if passive motion be kept up.

Partial dislocation. The previous observations refer to complete dislocations. It remains that something be said about partial dislocation. This injury is rarely met with in the large enarthrodial joints; whether because it really only occurs thus rarely, or whether in part from the difficulty of diagnosis, may be a question; but the rarity of undoubted specimens to be found in our great museums, and still more the rarity of dissections of these injuries soon after the occurrence of the accident, leave little doubt that the lesion is not common. It need hardly be said, at the present day, that the great majority of the specimens which used to be described as "partial dislocation" are really instances of displacement from disease.

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having *pulled off* a man's thumb in vain attempts to reduce a dislocation. I cannot find on what authority this story rests; but gangrene has no doubt often followed such attempts.

The symptoms of partial would be the same as those of complete dislocation, only less strongly marked, viz. sudden loss of motion, change of shape (independent of other concomitant injuries), and change in direction of the axis of the limb. But it will be at once allowed, by any one who has seen much of surgical practice, how difficult it is to distinguish these symptoms in the case of a deeply-seated joint from the effects of severe contusion or impacted fracture; and hence in such joints the diagnosis must remain rather uncertain. In some articulations, however, such as the knee, where the bones are in contact by very wide surfaces, any dislocation which occurs is almost necessarily partial, and here the diagnosis can generally be easily made.

The treatment, however, must be regulated by general principles, even if the diagnosis remain somewhat doubtful. The limb must be manipulated, under chloroform if necessary, until its axis is natural and its length corresponds with the other, and it is, if possible, restored to free passive motion; and it must be then confined to this position for as long a period as may be judged necessary.

The progress of the case will generally afford valuable information as to the presence or absence of fracture; since if the ligaments merely be ruptured, and the bones partially displaced, sufficient solidity is very soon obtained to restore at least some extent of motion; while in fracture the limb continues for a long period quite as helpless as on the first receipt of the injury; for the uniting medium even in the smallest bones does not acquire sufficient solidity to allow of voluntary motion for at least a fortnight; and a much longer period is required in the large bones of the limbs, which are the usual subjects of such an accident as is here spoken of. Ecchymoses also appear, *cæteris paribus*, to be more extensive and persistent in fractures than in other injuries.*

Compound dislocation is an accident rarely met with uncomplicated, except in the ankle-joint, or some of the articulations of the fingers, as the metacarpo-phalangeal joint of the thumb. Rules for the treatment of each special accident, deduced from experience, will be found in other parts of this work. The general considerations which should guide us in treating these injuries appear to be:

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* Packard's *Malgaigne*, pp. 84, 418.

1. That the injury does not of itself call for amputation, unless perhaps in the knee.

2. That if the head of the bone protrudes from the wound, it is better to remove it than to make any violent efforts at reduction.

3. That it is always better to excise the end or ends of the bones when the joint is one in which anchylosis is specially to be deprecated.

4. That in the joints of the lower extremity no bone should be removed unless absolutely necessary, and every attempt made, by enforcing strict rest and confined position, to induce anchylosis.

The prognosis of compound dislocations of large joints is highly unfavourable; and in any joint anchylosis will most probably ensue, though in the fingers it may sometimes be obviated by timely passive motion.

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